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STATE INSTITUTE OF EDUCATION

FARM CROPS
Book One

S. H. Bullivant

RURAL EDUCATION

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Farm Crops I

(Excluding Cereals, Grasses and Clovers)

2014

RURAL EDUCATION

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2014

RURAL EDUCATION

Farm Crops I

(Excluding Cereals, Grasses and Clovers)

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Foreword

From the earliest times man has domesticated wild animals and cultivated plants for his livelihood, for decoration and for interest. Even today, they are sought in all parts of the world for study, to add to collections or to contribute to the breeding of new hybrids. For six thousand years or more, people have tilled the soil, tended crops and fed livestock. Industrial development is relatively recent, and it is not surprising that many city-dwellers continue to concern themselves with cultivating plants in gardens and keeping small animals. Industrial methods and equipment in their turn have greatly influenced farming, and will continue to do so to an even greater extent.

This rural education series is designed for all young people—whether they live in town or country—who are interested in living things and how they grow. Each book is written by an author with a particular interest in the selected topic, and together the books cover a wide field. Many suggestions are made for observations, investigations and experiments, and it is important that you should keep careful records of your work. As well as finding out at first hand, you will need to use reference books, magazines, leaflets, etc.

Many people have made valuable contributions to the production of this series, by reading the topic books and offering suggestions. In particular, the editor and publishers are grateful to Mr. L. C. Comber for his inspiration and advice throughout.

F.G.S.

Introduction

We live in an age of progress. In the past fifty years, the borders of science have been pushed back at a tremendous rate. Atomic power and space travel have been removed from the pages of fiction to occupy headlines in our daily newspapers. In this country we have plenty to eat and our homes are warm and comfortable. We have considerable leisure time, and are able to travel anywhere in the world at great speed and in complete ease. Most of our illness and disease can now be cured. We have few of the worries and discomforts which beset our ancestors. In this age of science and progress, some people are apt to regard farming, one of the oldest of man's occupations, as out-of-date. Nothing could be further from the truth. Without food, scientific discovery and invention would quickly come to a halt.

Food is an essential need of all people. In early days man obtained food

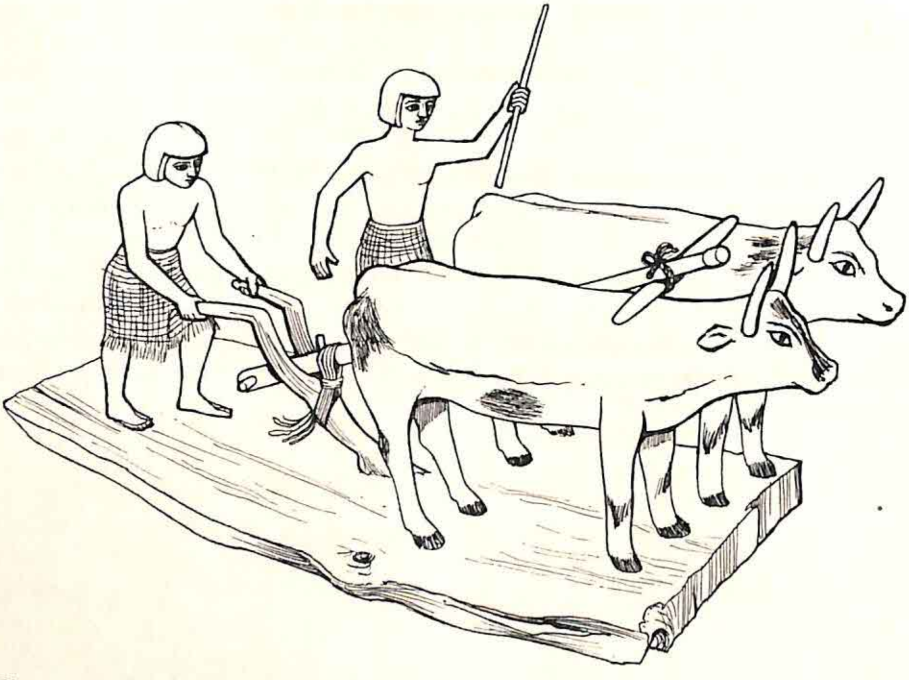


Fig. 1. Ancient Egyptian plough team

by hunting animals and gathering wild berries. However, you will know from your geography lessons that tribes which rely completely on hunting are liable to suffer acute food shortages. Man turned to farming as a more certain way of securing sufficient food. The first farmers were only concerned with food for their own families, Fig. 1. Later, farmers exchanged food for goods which they themselves were not always able to make. In this way the first markets came into being. Now food is supplied to this country from many parts of the world. Make a list of the different foods you eat in one day. How many countries have supplied these foods? Why is this country unable to grow enough food to feed everyone? Today, 60 per cent of the world's population is still engaged in producing food.

Visitors from overseas travelling through the British countryside, often remark on the wonderful variety of scenery. Imagine you are standing on a hill overlooking an expanse of countryside in summer. You would see what visitors call "the patchwork quilt of fields". One field is brown in colour, another yellow, another green. Hardly any adjacent fields contain the same crop. Each field in the countryside before you belongs to a near-by farm. The field boundary is clearly marked by a hedge, ditch or fence. Each crop has been carefully planned and cultivated; nothing in front of you is there by chance. The type of crop grown on these farms depends on (*a*) soil; (*b*) climate; (*c*) rainfall; (*d*) altitude; (*e*) aspect. There may also be local influences such as nearness to a town. Broadly, how do these factors influence the pattern of British farming? Within the limits set by nature, a farmer arranges a system of cropping known as a rotation. Why is it necessary to plan the position of each crop on the farm? The crops making up a rotation may be classed as (*a*) Roots; (*b*) Pulses; (*c*) Forage crops; (*d*) Miscellaneous; (*e*) Cereals; (*f*) Clovers and grasses. Pulse crops contain leguminous plants cultivated for their seed. Forage crops are eaten in the green state by animals. The first four crop groups are included in this book. Cereals, grasses and clovers are described in the companion book on farm crops.

All the crops in the above groups, with the exception of flax, are grown for feeding to animals or man. Food eaten provides energy which enables man to work. Most farm animals are fed in order to supply man with different forms of food. For example, cows produce milk and beef, pigs produce bacon and pork, and poultry produce eggs and meat. Which farm animal is fed largely to produce energy? Most of our own food may be eaten in the raw state by farm animals. Unfortunately, we are unable to eat all the foods fed to animals. Which animal foods are never eaten by man? How does the digestive system of the ruminant (cows and sheep) enable these animals to eat foods different from our own?

All foods eaten by animals or man may be classified as (*a*) Carbohydrates; (*b*) Fats; and (*c*) Proteins, according to their main food constituent. Each day you will eat some of these foods. Carbohydrates supply most of our energy, and are made in the plant from carbon, hydrogen and oxygen. You will already know how water, which provides the hydrogen and oxygen, enters the root of a plant. How does carbon enter the plant and by what processes is it converted into food materials? Our carbohydrates come mainly from bread, potatoes, sugar and porridge. Which foods provide animals with carbohydrates?

Fats also provide energy. The fats in our diet may be derived from animals or plants. What are the most common forms of animal fats in our diet? Most of our plant fats are imported, and have been made by the crushing of seed. Use the index to find the crops grown in this country for their seed oil content. Test for fat by rubbing a piece of any fatty substance (margarine or cooking fat) on filter paper. Dry the paper thoroughly. The grease spot on the paper shows the presence of fat.

The third type of food is protein which forms an important part of the protoplasm in our body cells. Why is protein necessary in our diet? How does

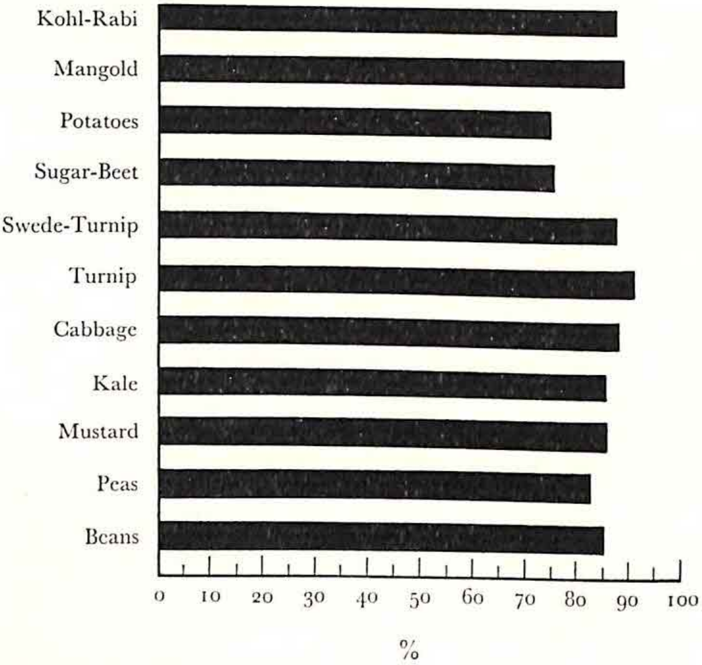


Fig. 2. Water content of some farm crops

the protein requirement differ between an adult and a child? Meat, cheese, eggs, fish and milk provide our proteins. You will realize that every type of food eaten by man or animal comes directly or indirectly from plants.

All the foods we eat contain a certain amount of water. This is important when we assess the food value of any particular farm crop, Fig. 2. For example, three-quarters of the potato is water, and only one-quarter is dry matter or "food". The yield from an acre of potatoes may be as high as 20 tons, or 5 tons of food. Wheat has only 15 per cent water. If a wheat crop yields one ton of grain to the acre, how much of this is food? You can make a table of total food yields by using this method. It is not difficult to find the approximate percentage of water in a plant or foodstuff. First, use a balance to determine the weight. Heat gently to drive off water, and weigh again. The loss in weight is approximately equivalent to the percentage of water. Heat the residue strongly in an open dish until you obtain a white ash. This contains the minerals of the food or plant. The most important minerals we obtain from plants are phosphorus, calcium and iron, and these in turn have to be supplied to plants by applications of manures and fertilizers. The need for fertilizer becomes more obvious when the part of the crop we use for food is analysed for mineral content. Peas, for example, contain 1 per cent potash. If the average yield of peas is 1 ton to the acre, how many pounds of potash are removed by each crop? What percentage is this of the common 1 cwt. per acre application?

On the farm, plant foods are constantly being removed in the form of crops or animal produce. Every mouthful of grass consumed by a cow contains plant nutrients for conversion into milk. It is important to remember that everything which is sold off the farm has to be replaced in the soil if its fertility is to be maintained. Plant foods supplied in the form of fertilizers and manures are constantly being lost to the soil.

FARM VISIT CARD

Name of farmer.. *Location of farm*.. *Date Visited*..................................

Field name or number	Type of Soil	Acreage	Crop	Seed rate per acre	Fertilizer applied	Use made of Crop	Weeds Observed

Fig. 3. A farm visit card

On a visit to a farm it is important to collect as much information as possible. You will be able to learn much by just looking around and the farmer will be able to provide additional details. Everything of interest should be noted, and the information analysed on your return. It is a good idea to use some form of information card, Fig. 3. You will see how it is possible to collect in a few minutes a number of important details about each farm crop. It is easier to carry out laboratory tests if farm crops are grown in the school grounds. Similar cards for farm machinery may also be used.

It is not possible to mechanize all stages of crop growing, as it is, for instance, in the production of a motorcar. Nevertheless, the revolution that has taken place in British farming methods in the past fifty years owes much to the development of machinery. As wages increase, it becomes more and more important to reduce labour costs by using machinery. In the past few years, many of the laborious tasks on the farm have been eliminated. Brawn has been replaced by brain. Today, the modern farmer and farm worker require considerable technical skill and training. On a farm visit, you will note the wide range of farm machinery. Imagine the repair bill of a farmer whose men were untrained and negligent in their handling of this machinery!

All too often we take our food for granted. Every meal we eat comes indirectly or directly from plants grown in the garden or field. Great skill and patience are required to sow and tend a farm crop. There is a constant battle against weeds, pests and diseases. Even at harvest time, bad weather may destroy a year's hard work. From the study of farm crops you will appreciate the judgement and knowledge required of the farmer in producing our food.

Further Reading

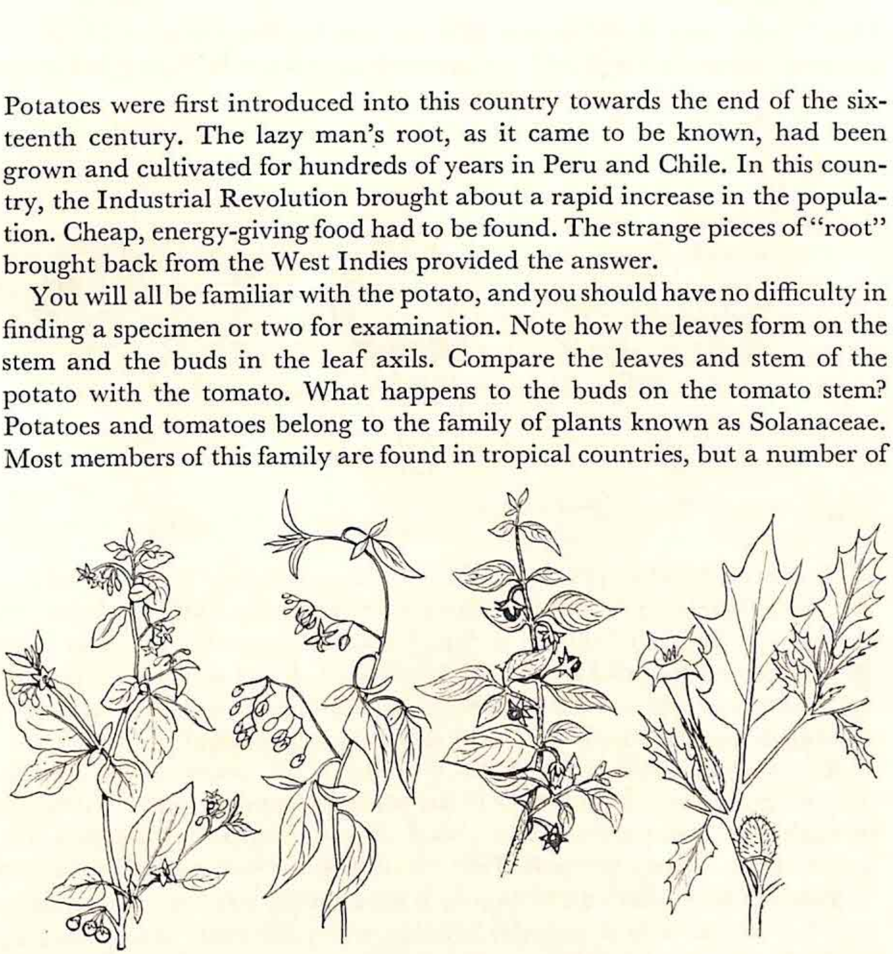
The Story of Agriculture by J. G. CROWTHER (HAMISH HAMILTON).
Farming – An Introduction by R. EDE (PITMAN).
A History of English Farming by C. S. ORWIN (NELSON).
The Farm by A. VOYSEY. Y.F.C. PUBLICATION (EVANS BROS.).
The Diversity of Life by L. E. MORRIS (CHATTO).
The Farmer's Tools by G. E. FUSSELL (MELROSE).

Chapter 1

Farm Potatoes

Potatoes were first introduced into this country towards the end of the sixteenth century. The lazy man's root, as it came to be known, had been grown and cultivated for hundreds of years in Peru and Chile. In this country, the Industrial Revolution brought about a rapid increase in the population. Cheap, energy-giving food had to be found. The strange pieces of "root" brought back from the West Indies provided the answer.

You will all be familiar with the potato, and you should have no difficulty in finding a specimen or two for examination. Note how the leaves form on the stem and the buds in the leaf axils. Compare the leaves and stem of the potato with the tomato. What happens to the buds on the tomato stem? Potatoes and tomatoes belong to the family of plants known as Solanaceae. Most members of this family are found in tropical countries, but a number of

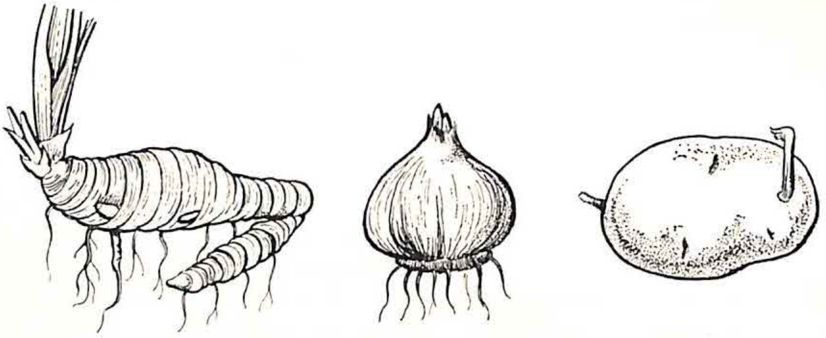


Black Nightshade Woody Nightshade Deadly Nightshade Thorn Apple

Fig. 4. Poisonous weeds of potato family (Solanaceae)

wild and cultivated flowers grow in this country. Woody Nightshade can be found in many hedgerows, Black Nightshade is an arable weed, and Deadly Nightshade, which is very poisonous, grows on chalky soils. Common garden flowers of the Solanaceae family are the many varieties of Petunia, and Winter Cherry. Try to gather leaves and fruits of the above plants. Note any similarities. Are the leaves single or compound? Examine the flower structure. Do all members of the Solanaceae family have the same number of sepals, petals and stamens?

The potato is really a piece of underground stem known as a tuber. Which other plants are grown from tubers? Compare the tuber with a rhizome, corm, and a Jerusalem Artichoke. Find the buds and leaf scars.



Rhizome (Iris) Corm (Crocus) Tuber (Potato)

Fig. 5. Some methods of food storage

Examine a sample of potatoes. Note the shape and colour. Does this vary with different varieties? Scrape away a little of the skin with your fingernail. Is your specimen an "old" or a "new" potato? Notice the thickness of the skin. Much of the protein value of the potato is found directly beneath the skin. What happens when potatoes are prepared for cooking? How is it possible to remove the skin and still retain the food value?

About 75 per cent of the potato is water. How would you prove this? Liquids enter the root and move in the plant by a process known as osmosis. Select three large potatoes. Cut a slice off one end and peel the first inch. Cut a cavity in the other end. Take two dishes and put one potato in each. Fill the first dish with water and pour a strong sugar solution into the cavity. Fill the second dish with sugar solution and pour water into the cavity. Watch both levels. What happens? Try to account for this. What do we learn about potato sap from this experiment? Place the third potato in

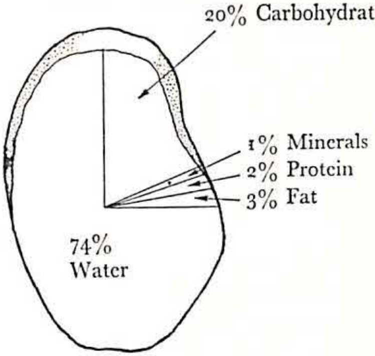


Fig. 6. Composition of a potato

boiling water for five minutes and repeat either of the first two experiments. What has happened to the plant cells? How has this affected osmosis? Why is salt added to the water in which potatoes are cooked?

How many types of food are provided by the potato? Vitamins B and C are also present.

Starch is made by the leaves using sunlight and carbon dioxide. What else is necessary? In ordinary green plants starch-making is carried on by small granules called chloroplasts, each containing the green pigment chlorophyll. What is the name given to the whole process? This is not possible with the potato tuber growing underground. Here the chloroplasts are without chlorophyll and are called leucoplasts. What happens when potatoes are exposed to light? How and why is this avoided by farmers and gardeners?

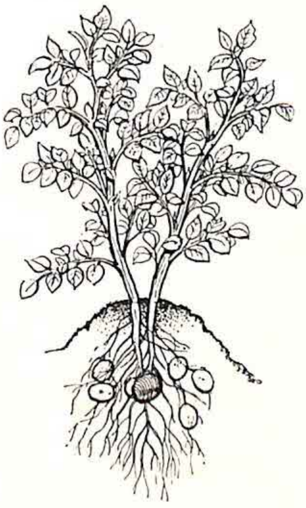


Fig. 7. The potato plant

The whole history of the potato in this country is very closely related to various pests and diseases. Most of the varieties used today are either linked with disease resistance or early ripening. Look through a seed catalogue and note the disease resistance of each variety. You will see that varieties are classed as First Early, Second Early or Maincrop. In which areas of Great Britain would you expect to find any one of these classes of potato? Why? About 60 per cent of all potatoes grown in England and Wales are Majestic, and 22 per cent King Edward. Why are other varieties seldom grown on the farm, but often in the garden?

The yield a farmer can expect from a crop of potatoes depends largely on the source of the "seed" used. "Certified Seed" comes from crops inspected and declared free from disease. What else is shown on the sale certificate? What is "Once Grown Seed"? Most diseases of seed potatoes may be

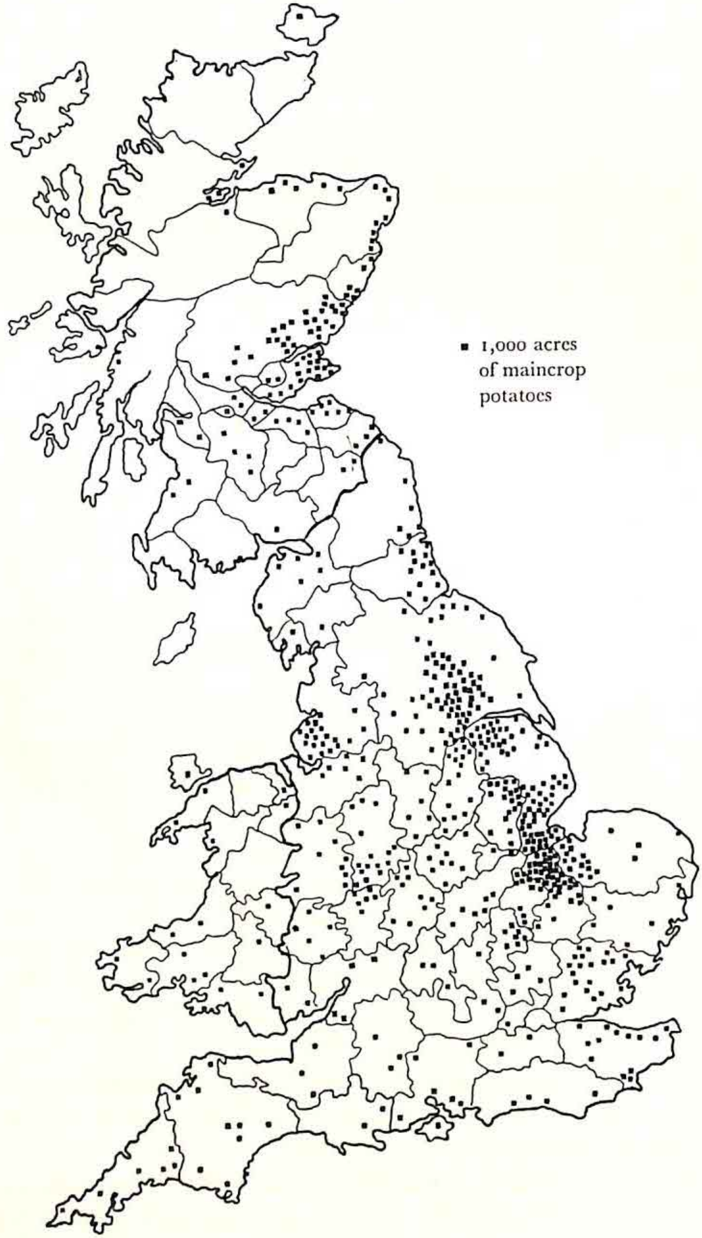


Fig. 8. Potato growing areas of Great Britain. Each dot represents 1,000 acres of maincrop potatoes

recognized by careful inspection. Virus-infected tubers, however, cannot be distinguished. These diseases are transmitted by aphids. Which other plants are attacked by aphids? Which part of the plant is attacked?

(Common usage has led to the use of the term "seed" for tubers or sets. How do they differ from the true seed?)

The virus infections which cause Leaf Roll and Severe Mosaic, travel through the haulm into the tuber. Here they remain in a state of dormancy until the potato is planted. The resulting plant may show characteristic leaf curling (see illustration). The tubers are small and therefore liable to be used for seed. In what parts of the British Isles is it possible to grow potatoes free from virus infections? Examine growing potatoes for signs of virus disease. Dig out any diseased plants and compare the tubers with those from a healthy plant. Why are farmers anxious to remove all potatoes at lifting-time and leave no "groundkeepers"?

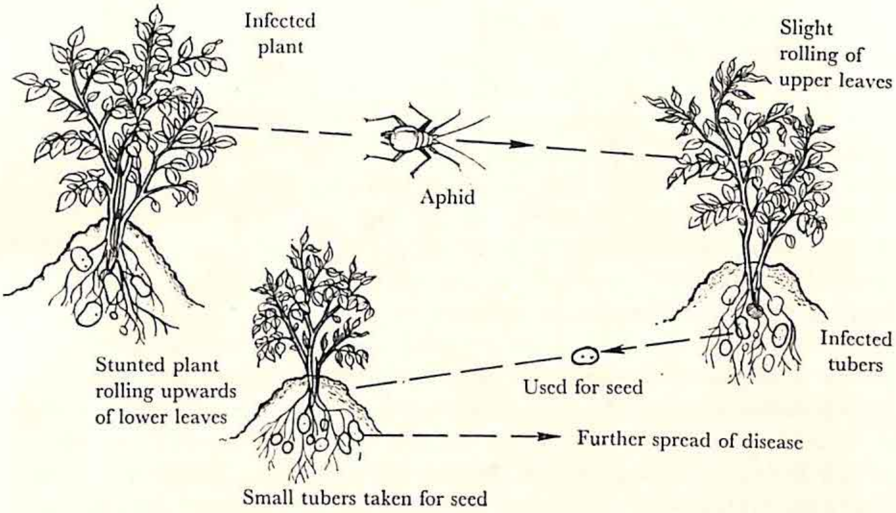

Infected plant
Slight rolling of upper leaves
Aphid
Infected tubers
Used for seed
Stunted plant rolling upwards of lower leaves
Further spread of disease
Small tubers taken for seed

Fig. 9. Leaf roll—a virus infection

The Potato Root Eelworm causes heavy losses of potatoes on many farms. An eelworm count will determine the number in the soil before planting. Using a one-inch carpenter's bit, take a number of soil samples throughout the field. Push it 4 inches into the ground every twenty paces. Break up these samples. Sieve to leave only fine soil. Weigh out 5 grammes and tip into a 250-c.c. flask. Add water and shake. Top up with water after two minutes. Examine the floating material with a hand lens. What is this called? The brown eelworm cysts will float on the surface. Carefully remove these with a piece of blotting paper and place on a microscope slide. Squeeze gently under a cover slip. Place under the microscope. What do you see? What causes the cyst to burst in the soil? How do eelworms move in the soil?

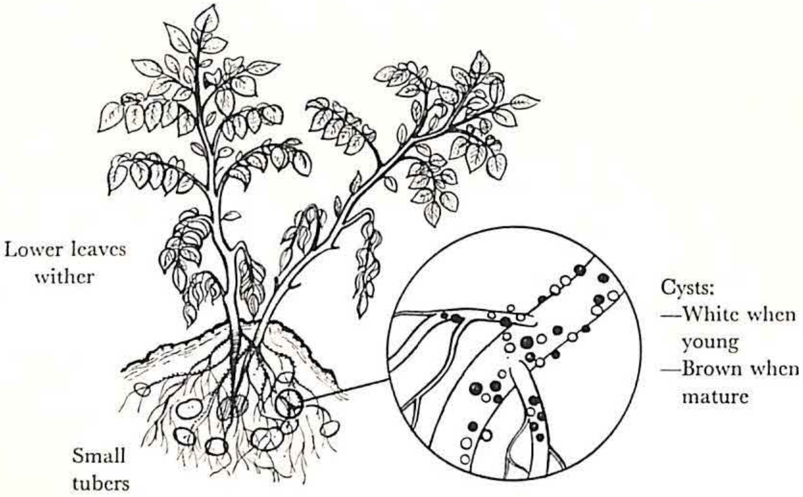


Fig. 10. Potato root eelworm

The cyst under the microscope is really an enlarged eelworm body. Eelworms feed on the roots of the potato and cause stunted growth or death. A large number of eggs are left in the cyst as it matures and drops off the root. The cyst is viable for about five years, during which time it may attack the roots of potatoes or tomatoes. How can the farmer make sure that eelworms will not ruin his crop of potatoes? Name some of the ways in which infected soil may be taken from one field to another. Distinguish eelworm cysts from leguminous root nodules.

Clean seed and a good rotation will also avoid the disease called Common Scab. Why are scab-infected potatoes difficult to sell? This disease is most common in soils lacking humus. How can the farmer raise the amount of humus in the soil before planting?

On arrival at the farm, seed potatoes are normally put into shallow wooden boxes. Examine one of these. What does the farmer call them? Why do they have slatted bottoms? What use is the connecting strip attached to the corner of every box? What is the average weight of potatoes in each? If the farmer uses 15 cwt. of seed per acre, how many boxes will he require?

Check the average width of the tubers with a ruler. Find the average weight. Approximately how many potatoes are planted per acre?

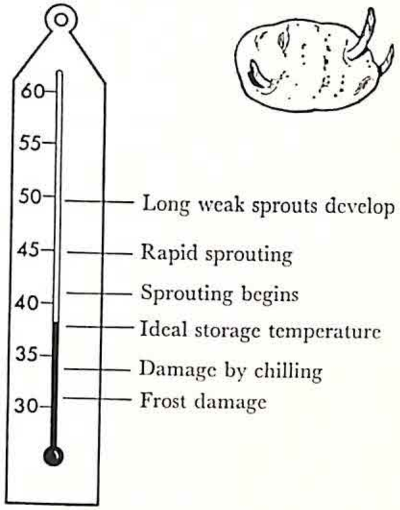


Fig. 11. Storing seed potatoes

The boxed potatoes are often stored in large greenhouses or granaries. Look for a thermometer inside the building. Why should it not be hung near the door? Check the temperature with the diagram opposite. What kind of heat is provided? How much fuel is used per week, and what is the cost? For how many weeks is it continued? How does the farmer make use of the building during the rest of the year?

Carefully examine any potatoes showing no signs of growth. Check the eyes of the tuber, using a hand lens. Note if any are dead. If so, you may be looking at the effects of a fungus disease known as Skin Spot. Sometimes 30 per cent of seed potatoes may be affected. Why is it so important for the farmer to look for this disease before planting? Pare off the skin from an infected tuber. Notice the dark, dead tissue. Is the infection confined to the eyes? What happens to the fungus growth when this potato is kept in a warm, damp place?

Also look for tubers that have become wrinkled or spongy, and which

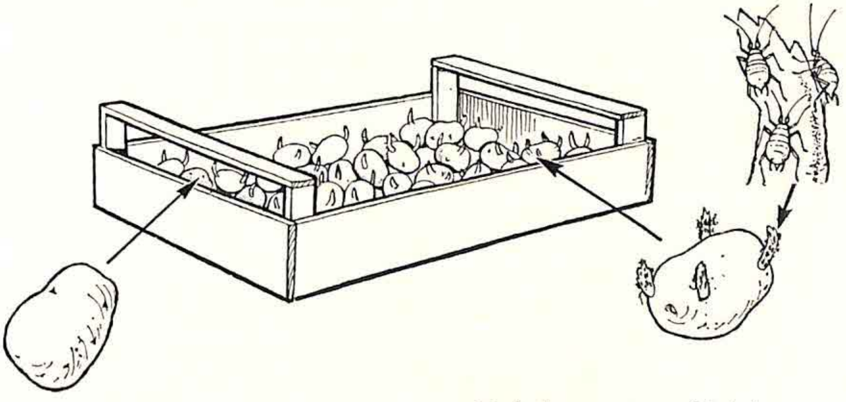


Fig. 12. "Skin spot" disease—an aphid-spread infection among seed potatoes

often develop white fungal growths. Again, examine with a hand lens. What is this disease? How is it caused? What happens to this seed? Also examine the potato shoots. Can you find any insect infection? What can the farmer do about this?

Light is very important in the chitting of potatoes. Allow two or three potatoes to sprout in a dark place. Compare the growths with specimens allowed to grow in the light. How do they differ? Weigh a potato. Sprout in a dark place. Weigh again. What has happened? Cut out a little of the potato where the shoots are sprouting. Chop it up finely and carry out the tests for sugar.

In the Netherlands, chitting houses are often fitted with fluorescent lighting. Sprouting is controlled by light intensity and temperature. This type of building is occasionally used on our own farms. In what circumstances would you expect to find such an expensive building?

The farmer does not always use the same methods of potato growing as the gardener. Labour costs and the time factor are more important on the farm. We shall see later how one machine can do the work of several men. Many gardeners cut the potato seed in half to economize. How should the cut be made? What type of seed will be used? Imagine that a farmer has been sent a consignment of large, maincrop seed potatoes, each weighing 3–4 oz. Using average plant and row distances, calculate the number of potatoes and the weight required per acre. From a farm seed catalogue find the cost. Carefully cut a few potatoes noting the time taken. Estimate the time needed to cut the number of seed potatoes required for one acre. What is the labour cost to the farmer? Check this amount with the ordinary seed price.

You will know the part played by potatoes in a rotation and remember that potatoes are often grown after a ley. Examine a ley, note the proportion of clovers to grasses, and work out how the ploughing in of these plants will benefit the potato crop. However, there are various larvae which live harmlessly in grassland, but may cause much damage when the field has arable crops. Which larvae bore holes, and live in the potato? How does the farmer avoid this danger?

Ploughing is normally done in the autumn, particularly in areas of heavy soils. Why is this? The depth of ploughing is very important, as potato crops require a deep tilth. If you are on a farm walk find out which tractor and plough are used for this work. Obtain the farmer's permission to use a soil auger. Find the depth of cultivated soil. Take samples from two or three fields. Build up a number of soil profiles (see Fig. 13), and relate these to crop yields in the autumn.

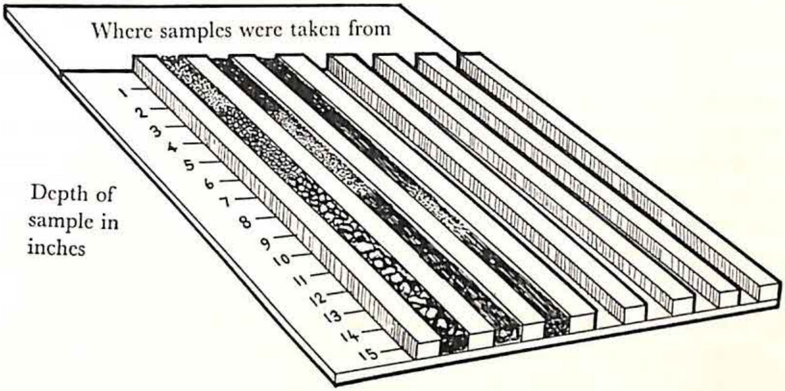


Fig. 13. Soil samples from the farm

Great care is taken by the farmer to ensure the best possible cultivation and fertility. The costs are heavy but the profits expected are high. A wise farmer realizes the importance of the water available in soil. An application of 15 tons per acre of farmyard manure contains on average: 12 tons of water, 1½ cwt. of potash, 1½ cwt. of nitrogen and ¾ cwt. of phosphoric acid. How does each of these foods help the plant? What substitute for farmyard manure is often used in Cornwall and the Channel Islands? Which soils have least need of farmyard manure?

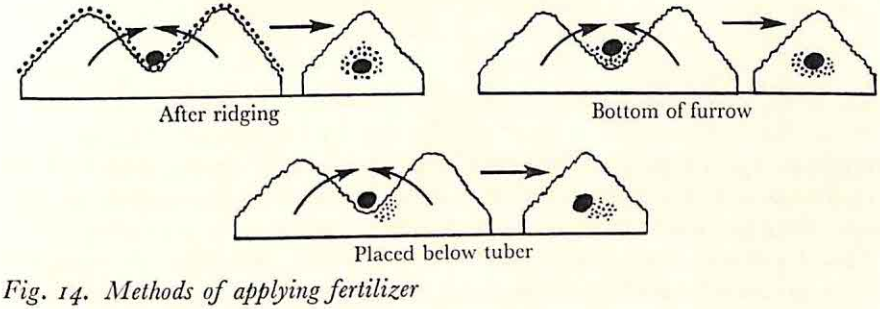


Fig. 14. Methods of applying fertilizer

Fertilizers are often used instead of, or to supplement, applications of manure. On a farm walk, find out if manure has been applied to the potato fields, and the amount per acre. Were fertilizers also used? Had the field been soil-tested in order to determine any deficiencies? Who had carried out these tests, and what were the results? Fen soils may show symptoms of a serious deficiency of magnesium. In this case, magnesium sulphate will be sprayed on the growing crop.

You may like to check the results of recent experiments in the application of fertilizers. It has been shown that 50 per cent of the fertilizers applied to the potato crop may be saved if the dressing is placed near the seed. This is called "fertilizer placement". Place lines of a complete fertilizer by some tubers at planting time. Check yields with potatoes receiving normal ridge applications. Some mechanical planters are adapted to place fertilizer 2 in. away from the tuber. Why is it not put directly above the potato?

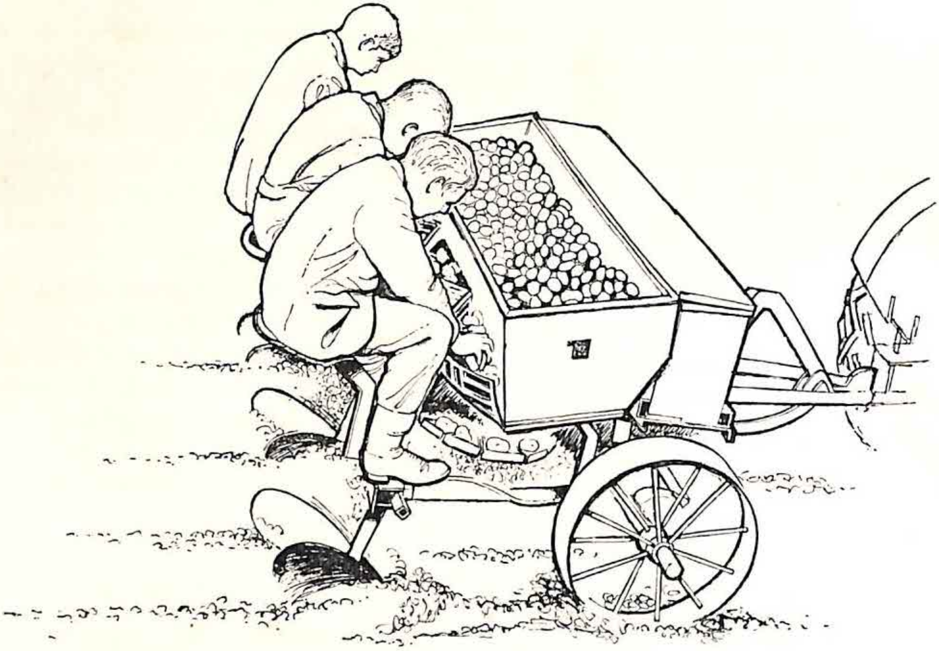


Fig. 15. Three-row planter with fertilizer attachment

Most potato planting on our farms is done by machine during April. There is a machine which requires only one operator, and plants three rows at a time. Another (see illustration) requires one operator per row. Potatoes are fed into small cups mounted on rotating discs. It is possible to regulate the distances between the potatoes and their depth. The hand-fed potato planters require operators to drop tubers at regular intervals. Ridging-tool bars are used in preparations for planting, and for moulding up the crop later in the season. On small farms, hand planting is still used.

Find out the plant distances and depth used by the farmer. Experiment in the garden, varying the row distance and depth. Are these changed for early potatoes? In the school garden it is possible to carry out a number of manure and fertilizer experiments. Plant the same number and variety of tubers in separate squares and vary the manurial treatment. Enter on labels the equivalent amount of manure and fertilizer per acre received by farm potatoes. Weigh tubers from each plant at lifting time. Yields will probably vary but do not assume that differences are entirely due to the fertilizers. What other factors might be responsible?

After planting is completed, the farmer will try to germinate as many weeds as possible before any potato shoots appear. This is often done by setting up high ridges. When weeds appear, these ridges are broken down with a flexible chain harrow and the weeds destroyed. Collect samples of top soil from a potato field. Place in shallow dishes and keep just damp. Note the number and types of germinating seeds, naming seedlings where possible.

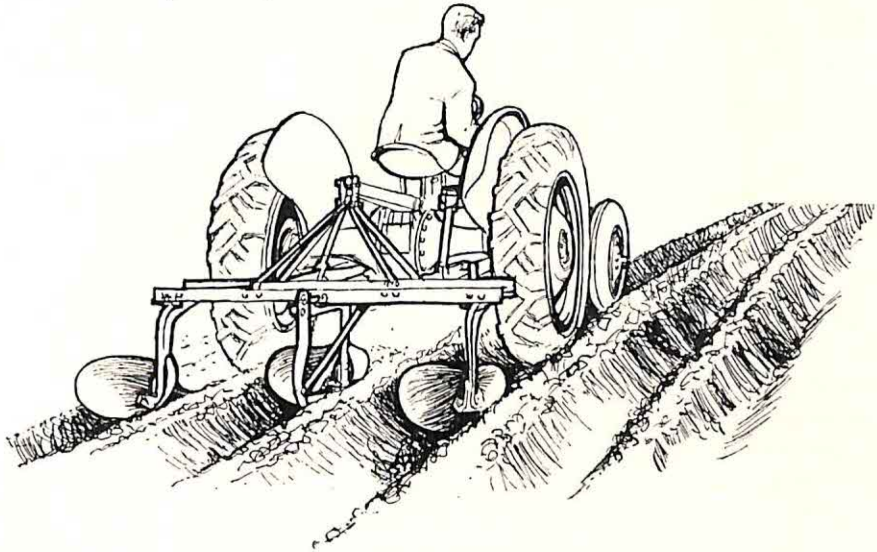


Fig. 16. A three-row ridger at work

Great care has to be taken in the growing of first early potatoes. The plant is not native to this country, and a frost in spring may severely affect yields. What are the symptoms of frost damage? How can the farmer reduce this risk? Recent research has shown that continuous irrigation during times of frost will reduce damage; soil temperature remains highest with a large water content. This will protect the young potato shoots. Try to check this research in the garden.

When potato shoots are showing, weeding implements must only disturb the top 2–3 in. of soil. The final cultivation in July will be to use a three-row ridger and raise up soil round the plant stems. Why is this important? The foliage cover will now smother further weed growth.

In mid-July the farmer may spray potatoes against Blight. This has been the most serious of the potato diseases. Blight caused the Irish Famine of 1846.

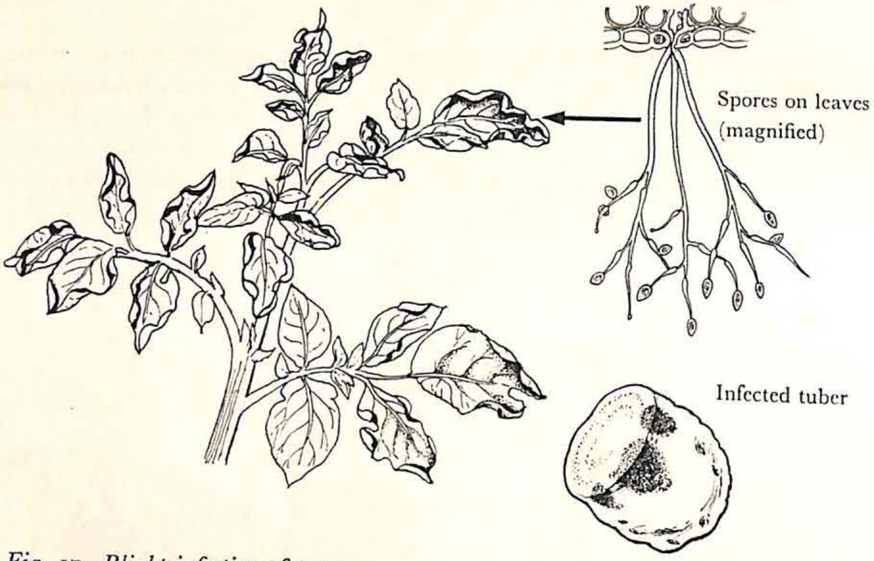


Fig. 17. Blight infection of potatoes

Search among plants for water-sodden patches on the leaf tips. Examine the under-surface with a lens. What do you see? Where have the fungi entered the leaf? How will blight affect the crop yield? Transfer one of the spores to a microscope slide. Crush with a cover slip. Examine under the microscope. How are these spores spread? In what type of weather? Spores falling on to unearthed tubers will affect them also, and it is slightly infected seed which starts the trouble. Open any infected tubers and trace the areas of infection. How do these differ from a potato virus infection? Has the farmer any use for these potatoes?

Spraying to avoid Blight damage must be completed before any symptoms appear. Bordeaux Mixture—copper sulphate and lime—is generally used. Rain does not easily wash off this spray. On a farm, you may be able to examine a spraying machine. Find out how many gallons per acre are applied.

In order to breed strains resistant to Blight, plant breeders import potatoes from the Continent of origin—South America. Farmers growing potatoes for seed make regular inspections of the growing crop. In each variety all plants showing symptoms of virus or fungal disease are removed and destroyed together with plants not true to the variety. This is called "rogueing". How do occasional plants of other varieties get into the crop? Crops of potatoes growing on the South Coast are also kept under close observation; a constant watch is maintained for a rare, but extremely destructive pest. Do you know the name of this pest, and how it reaches this country? What damage may be caused?

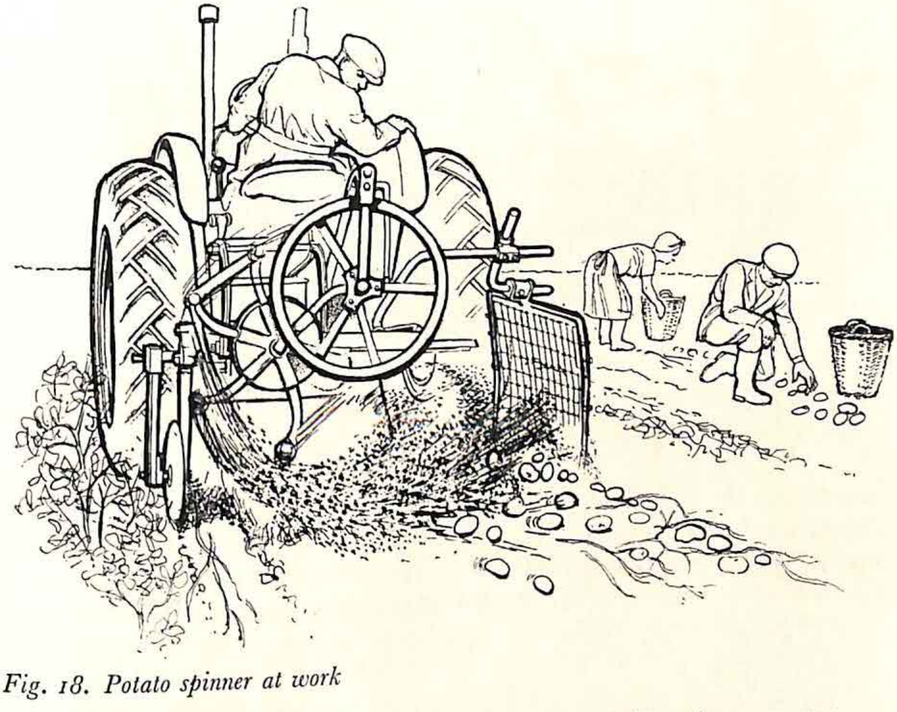


Fig. 18. Potato spinner at work

Garden potatoes are often dug much earlier than field maincrop potatoes. What signs of maturity does the gardener look for? Farm potatoes are usually lifted in October after the corn harvest. Most of the haulm is then dead. In Blight-infected areas, it is unwise to expose potatoes whilst any haulm remains. Blight-contaminated tubers will go rotten during storage. All haulms should be destroyed. Find out the type of sprayer used for this purpose. What sprays are used? How soon are they applied before lifting time?

There are five ways in which potatoes are lifted. Hand forking is very expensive and slow, and only used if the value of the crop is high. Damage is reduced to a minimum. The lifting plough consists of a renewable share and iron raising prongs. This is attached to the tractor tool bar. There are no moving parts. On what type of soil will this machine be of greatest use? If you are able to watch a lifting plough at work, note the obvious disadvantage of this method.

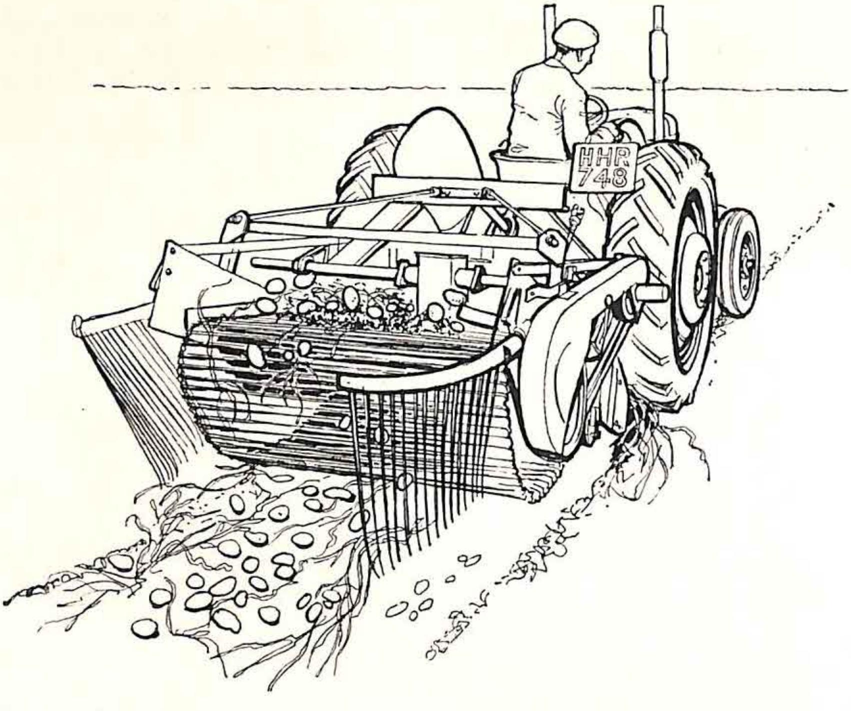


Fig. 19. Potato elevator digger

Three-quarters of all the potatoes grown in Great Britain are lifted by the potato spinner. If possible, examine one of these machines. How much does it cost? Is the spinner towed by the tractor or driven from the power take-off? What is the name given to the sharp wheel which raises the ridge? Why is adjustment in depth work so important? How is the speed of the revolving tines adjusted? Why should this be necessary? How are tubers prevented

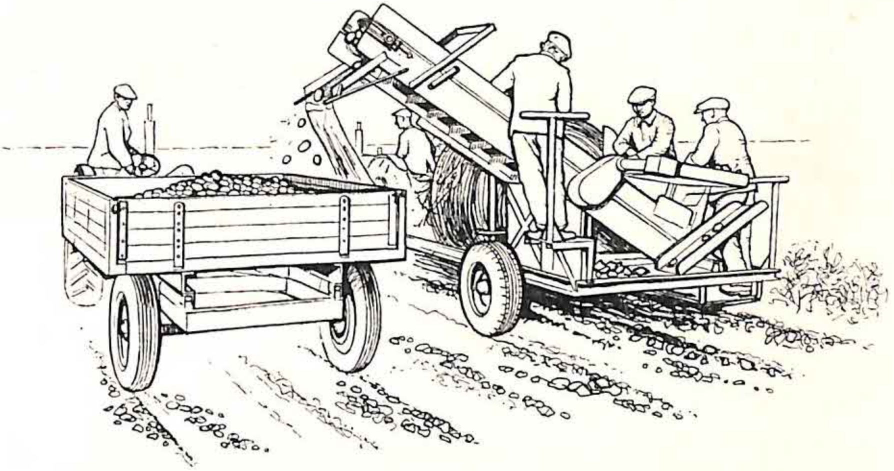


Fig. 20. Complete potato harvester

from being thrown too far? Note also whether the farmer has fixed rubber tubing over the prongs to reduce bruising.

About fifteen workers will be required to pick after each spinner. Potatoes are placed in open mesh baskets or skips, and tipped into a tractor-pulled trailer. One spinner can lift half an acre per hour, Using current agricultural wage rates, work out the labour costs of lifting one acre of potatoes. When is it not possible to use this machine?

The elevator digger is not so regular. It is slightly slower than the spinner, but potatoes are easier to pick. Farmers complain that this machine gives a lot of trouble. If you are able to examine an elevator digger, suggest why these breakdowns are common.

Find out the cost of a complete potato harvester. Using this implement, a gang of six can raise, cart and clamp 2½ acres per day. This is only possible in stone-free soil. Estimate how many acres of potatoes a farmer would have to grow in order to justify the purchase of this machine. Several countries have co-operative systems in their farming methods. A costly implement such as a complete potato harvester would be used by a group of farmers. What are the advantages of such a scheme? Why are British farmers reluctant to co-operate in this way?

Potatoes are carefully examined at lifting time. A farmer will want to discover whether the lifting implement is bruising the tubers. This damage will result in potatoes developing black areas beneath the skin in storage. After ploughing up grassland, there is always the risk of wireworm damage.

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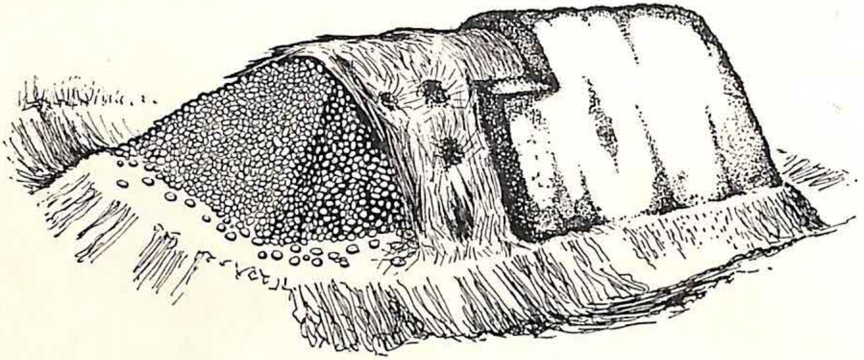

Fig. 21. Storing potatoes in a clamp

Examine tubers for any holes. Open the potatoes and try to locate these pests. What colour are they? Which other crops do they attack? What is the adult stage of this grub? Also examine for slug and millepede damage. How is it possible for a millepede to gain entry into a potato? All these pests can be reared for interest if fed on a supply of moist potatoes and kept cool.

When potatoes have been taken out of the ground they are transported away for storage. Potatoes may be stored outside in a clamp or inside farm buildings. Both methods are satisfactory if the potatoes are sound, mature and reasonably dry.

Examine a potato clamp and note the location in relation to the potato field. Has the farmer placed it in the best position? Could this ground be easily flooded? Is it possible for transport to reach the site in winter? Measure the depth of straw covering the tubers. What type is it? How is the straw kept in place? What is the purpose of the straw? Note the absence of ventilation shafts? Is the clamp waterproof?

Measure the width of potatoes inside the clamp. The minimum width is normally 6 ft., and this is used when potatoes are wet or suspected of being infected with blight. The maximum width is 9 ft. The amount of potatoes inside a clamp varies from 10 cwt. per yard with a width of 6 ft., to 1 ton per yard with a width of 9 ft. Measure a clamp and estimate the tonnage of potatoes. What is the value at current market prices?

Many farmers now store potatoes in buildings. This has an obvious disadvantage when potato fields are distant. Straw is again used for insulation. Ventilation is provided by means of wooden ducts placed in the floor. Potatoes may be stacked to a height of 12 ft. Capacity is estimated at

56 cub. ft. per ton of potatoes, and you can calculate the total weight of a potato store by multiplying the length, breadth and height (in feet). How does the farmer take precautions in order to prevent the bottom of the building from being pushed out? A loading elevator is required to lift the potatoes.

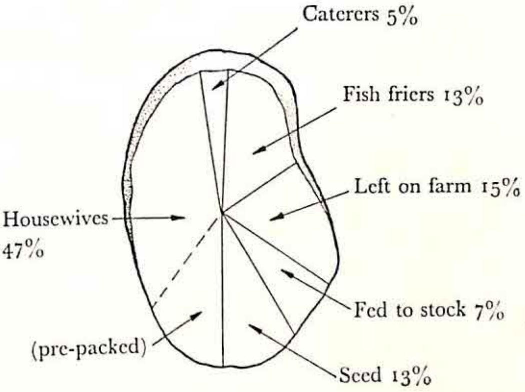

Fig. 22. How the potato crop is used

After a few months, potatoes are taken from their place of storage and prepared for marketing. The tubers are placed on a conveyor which takes them along to a number of riddles. Various sizes of riddles may be used. The Potato Marketing Board will arrange the size, depending on the estimated yield of the crop in the country. You may not have realized that oversized potatoes are only sold after the normal standards are met. Which storage system allows the farmer to sort potatoes during all weathers? How does potato riddling fit in with other farm work?

Potato dressing—as this is called—ensures the removal of diseased tubers, and only those of reasonable size and quality are sold. You will note from the fate of an average crop, that approximately one-quarter never leaves the farm. Find out the average price of potatoes per pound in the shops. Calculate the price paid per ton by the housewife. Using one of the farming journals, note the price paid to the farmer for a ton of potatoes. Are potatoes marketed in the most economical way?

Prepacked potatoes are becoming increasingly popular. What material is used in packaging? What disadvantage has a transparent material? What are the advantages of buying prepacked potatoes? Compare the price per ton with loose potatoes. Purchase a few pounds of both types and note any difference in quality. Is the variety marked on the packet? Does variety influence demand?

All potatoes are sold according to regulations laid down by the Potato Marketing Board. Prices vary according to the time of year and the district in which you live. It is interesting to find the wholesale and retail prices from a farming journal and compile a graph for a season. Grading stations will be set up in many parts of the country to ensure better selection and marketing. This will help both the public and the farmer to make the best use of the annual average 6-million-ton crop of potatoes.

Further Reading

Potato Growers Handbook – POTATO MARKETING BOARD, LONDON.
Farming Equipment by A. J. BROOKES (PITMAN).

Ministry of Agriculture Publications:

Potatoes, Bulletin No. 94.

Leaflets: COMMON SCAB (5); COLORADO BEETLE; BLACK LEG (107); POTATO VIRUS DISEASES (139); DRY ROT OF POTATOES (218); CUTWORMS (225); POTATO BLIGHT (271); WART DISEASE OF POTATOES (274); POTATO ROOT EELWORM (284); POWDERY SCAB OF POTATOES (99); MAINCROP POTATOES (470).

Chapter 2

Sugar Beet

If you ask a person living in a city, where sugar comes from, the reply will almost certainly be "sugar cane". Many people are not aware that one-quarter of all the sugar used in this country is grown on British farms. There may seem to be a great difference between the tropical cane-fields of Queensland and the West Indies, and the cold November sugar-beet fields of East Anglia. Both help to make life sweeter for us all.

The sugar beet grown in our fields has been bred from the original wild beet of the sea-shore. The Romans noticed the sweet taste of the wild beet on the shores of the Mediterranean, but many centuries were to pass before this sweetness would be converted into sugar crystals. In 1747, a German chemist produced sugar crystals from a species of Silesian white beet. Fifty years passed before the first sugar-beet factory was built in Silesia. During the Napoleonic wars, the Continental blockade caused a great scarcity of sugar. Napoleon granted State assistance to farmers growing sugar beet, and very soon the popularity of the crop spread beyond the borders of France and throughout the Continent of Europe.

In 1912, the first of our present sugar factories was opened at Cantley in Norfolk. During the next twenty years, several other factories were built as a result of interest and financial assistance from the Government. In 1936 the British Sugar Corporation was formed. This organization became responsible for the whole of the home-grown sugar industry. You will see from the sketch map the location of the eighteen factories operated by the B.S.C.

Both sugar beet and mangolds belong to the genus *Beta* of the Chenopodiaceae family. The Latin name for sugar beet is *Beta maritima.* How does this name associate sugar beet with the sea? The seed of beet is produced in a small hard cluster. If you can obtain some sugar beet "seed", carefully cut open the cluster with a sharp knife. How many seeds do you find in each cluster? What problem does this present to the farmer in the growing of sugar beet? Now it is possible to buy "rubbed seed" (see Fig. 24) which

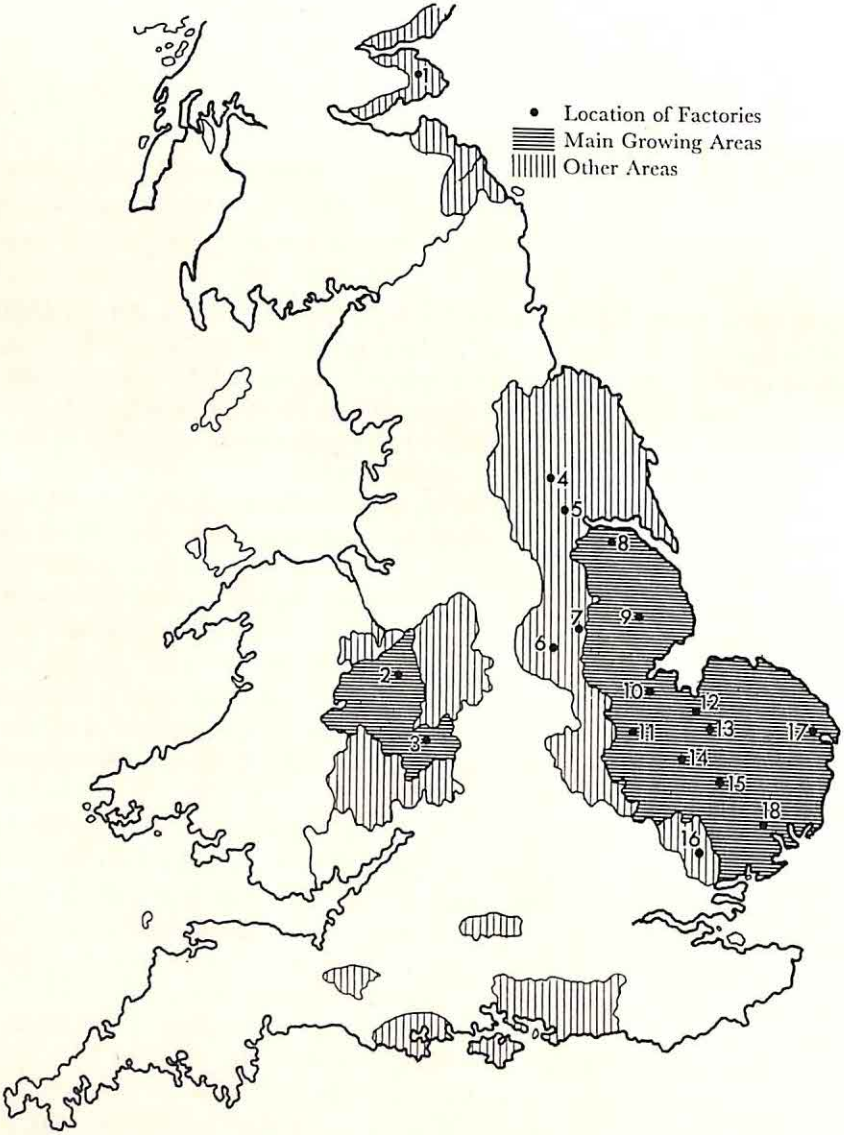

Fig. 23. Where sugar beet is grown and sugar extracted

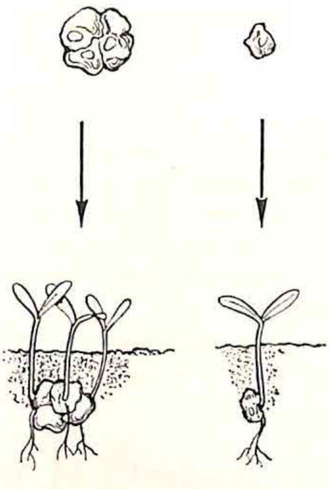

Fig. 24. Sugar-beet seed

gives more single plants at germination. Why is rolled seed liked by the farmer? Germinate a few natural seed clusters and specimens of rolled seed. How many plants do you obtain from each? If you look through a farm seed catalogue, you will note the letters E, N or Z before each variety. Varieties of the E group of sugar beet give high yields, while N varieties are high sugar producers. Z strains produce only small yields of roots, but with a high content of sugar. This variety is particularly suitable for wet areas, as it matures in early autumn. On a farm walk, find out the strain of seed grown and why it was chosen.

The seedbed preparations for sugar beet begin immediately the previous crop has been removed in the autumn. When beet is to follow cereals, the stubbles are generally broken up with a cultivator. How does this cultivation succeed in removing many annual weeds? Farmyard manure is also applied in the autumn. Why is it necessary to plough in manure immediately? Is deep ploughing essential? If these cultivations are completed in the autumn, the seedbed will benefit from the winter "frost mould".

Fertilizers are applied about three weeks before sowing. It is false economy to apply a basic fertilizer dressing only. Sugar beet responds well to heavy applications of fertilizers. Five cwt. of sulphate of ammonia and 3 cwt. each of superphosphate and muriate of potash are normally applied. Find the total cost of these fertilizers from one of the farming journals, together with the actual amounts of nitrogen, potash and phosphorus. A compound fertilizer supplies all three chemicals at the same time. Why is salt sometimes applied to the seedbed?

You will be able to see sugar-beet seed being sown during the last two weeks of March. The sowing rate is 15–20 lb. per acre. Most of the labour cost in growing the crop results from the singling operations. The machine used in sowing seed can reduce the amount of singling, e.g., a spacing-drill, which delivers seed at regular intervals. This machine is in general use in the U.S.A. for sowing the maize crop. How would a spacing-drill reduce the labour cost of singling? Whichever method of sowing is used, seed must be placed in straight lines. Why is this more necessary than with cereal crops?

Immediately the rows of young beet are visible, the long and laborious task of singling plants begins. Measure between plants. You will find the average distances are 18 in. between rows and 12 in. between plants. An acre of sugar beet with these measurements should produce between 30,000 and 35,000 plants. Farm workers are often paid for singling according to the number of plants remaining for the crop. You can estimate the acreage plant population by constructing a wooden frame a yard square. Throw this frame out into the beet field at regular intervals throughout one acre. Carefully count the number of plants each time. Estimate the acreage plant population from the average number in each square yard.

In the factory and on the farm, progress depends on mechanization. You will see in the illustration a machine designed to mechanize the singling of root crops. Small rotating blades remove plants at predetermined distances. Why are circular brushes needed each side of the "gappers"?

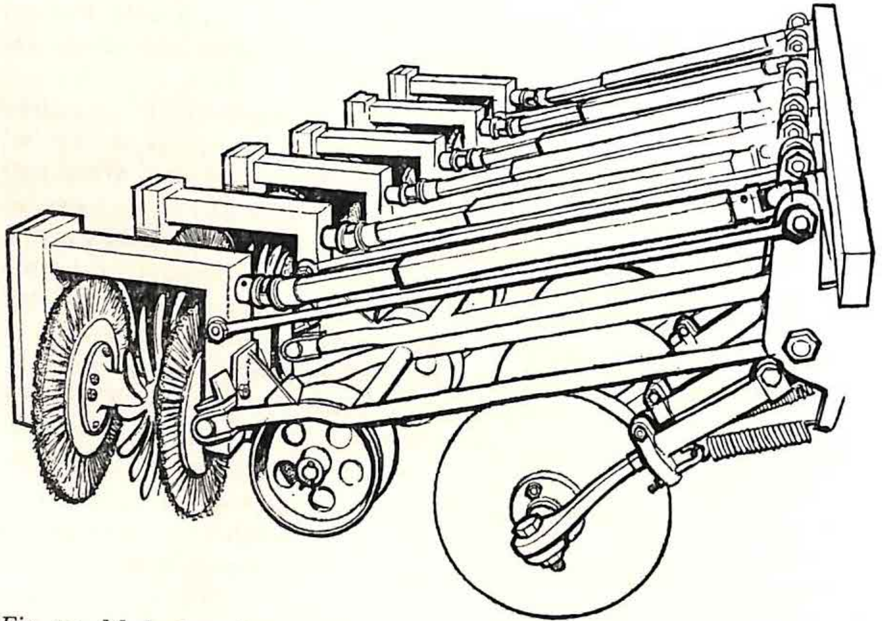

Fig. 25. Mechanism of a root crop "Gapper"

During the early summer you will be able to see several kinds of mechanical hoes at work. Observe how many of the tractors being used are relatively low-powered. Why is this? All of them have rubber tyres with only a small surface in contact with the ground. When plants are to be hoed in both directions, plant spacing is of special importance. On a farm walk you will see that the final inter-row cultivations take place just before the leaves meet across the rows. Why are inter-row cultivations necessary?

A visit to a farm in late July is the best time to search for symptoms of Sugar Beet Yellows. This is a virus disease affecting both sugar beet and mangolds. Can you remember from the previous chapter which group of insects is responsible for spreading virus diseases? Search among sugar-beet plants for specimens having outer or middle leaves turned yellow. If you are not successful, look for the same symptoms in September–October. You will notice the leaves go yellow, and eventually become brittle and break away. How does the loss of leaves have any effect on the final size of the root? At harvest time, dig up and weigh a number of healthy roots, and also a number showing signs of virus infection. A crop 100 per cent infected in July will halve the farmer's income from the sugar-beet crop. The virus can only be spread by aphids; not via the seed. Each crop, therefore, starts "clean" and the disease is brought into the field. How is the virus kept alive when sugar beet has been removed from the field? Which winter garden crops could act as host to the virus?

When sugar beet is grown too often on the same land, the crop may suffer from "beet sickness". This disease is caused by eelworms. Search in a beet field for patches among the crop. In this area, plants will be stunted and yellow. Pull up one or two specimens. What has happened to the root? Examine the mass of rootlets with a hand lens. Can you find the small lemon-shaped cysts? From the previous chapter, can you remember what happens to these cysts in the soil? How is infection spread? Why does the infected beet plant develop a mass of rootlets instead of a healthy tap root? How is it possible to prevent eelworm infestation?

Whilst searching among sugar beet for pests and diseases, you will notice a number of plants which have developed a long flower stem. The farmer calls this "bolting". Plants which bolt produce flowers and seed in one year instead of two. Pull up one or two of these plants and cut open the root. What has happened? How is the sugar content of the root affected? Plants which bolt before the final hoeing are snapped off at the crown. Leave a few bolters and observe the effect of flowering on the roots at harvest.

In October it is possible to get some idea of the crop yield. Pull out all the beet from a 3 or 6 ft. length of row. Clean all dirt from the roots and carefully cut away the crown and leaves. Find the average root weight and length. How many pounds of roots are obtained per yard of row? Find the total lengths of rows in one acre, and estimate the acreage yield. If the average sugar content is 16 per cent, find the total weight of sugar produced per acre.

What is the price of sugar at your local shop? Does this differ much from the price paid per pound to the farmer?

Sugar was first brought to this country by the Crusaders. Today it is the chief energy producer in our diet. Which foods have you eaten today containing sugar? Sugar is "made" inside the plants of sugar beet and sugar cane and to a lesser extent in many other plants. The chemical formula, $C_{12}H_{22}O_{11}$ shows the three elements required. How do carbon dioxide, hydrogen and oxygen get into the roots of sugar beet? Why is photosynthesis important in the making of sugar?

Sugar beet is mature and ready for lifting at the end of October or the beginning of November. If you have grown some sugar beet, try to pull up a few of the roots. You can imagine the physical effort required in pulling up several acres of sugar beet. Most farms today use a mechanical harvester. During October and November you will see many different sugar-beet harvesters at work. One of the most popular (see illustration) has a topping unit to remove the leaves and crown of the beet. Why is it necessary to be accurate in cutting off tops? The root is raised from the ground by a pair of vertical discs. These clasp and lift the root at the same time.

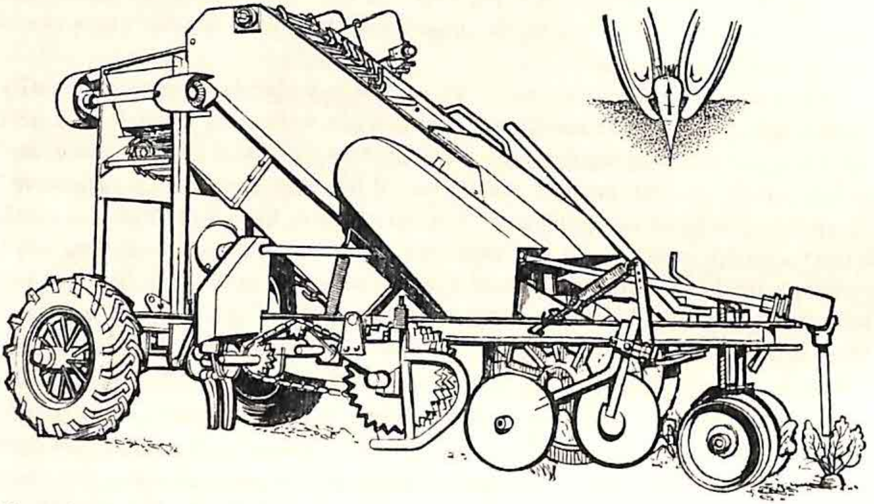

Fig. 26. A sugar-beet harvester

An elevator delivers the roots to a rotary cleaning cage. Here, much of the soil is shaken off and the cleaned roots are delivered into trailers alongside the harvester. The best place to see the sugar-beet harvesters available to farmers is at a County Agricultural Show. If you are able to watch one of these machines at work, note how many men are employed. Most machines are able to harvest 2½ acres per day. What is the labour cost per acre? Pull up part of a row by hand and remove tops. Note the time taken and the length of row completed. Calculate the labour cost in hand-pulling 1 acre of sugar beet. How much does the farmer save by the use of machinery? What is the cost of a complete harvester? What is the working life of this machine?

After beet has been loaded into a tractor-drawn trailer it may be taken away for temporary storage beside a hard road. Here the beet will await collection by the local factory. Beet stored in this way is liable to be damaged by frost. How is the farmer able to reduce the risk of frost damage? Which machine is used to load beet into lorries? Delivery to the factory is controlled by a system of permits. This method ensures that the factory is kept working at maximum production during the short winter season.

On a mixed farm, one of the main advantages of growing sugar beet is the value of by-products. You will remember how the crown and leaves of the beet are left behind after harvesting. Sugar-beet tops have a feeding value similar to kale; in acreage comparison the food value is one-half of the average kale crop. Why is food for livestock particularly valuable in areas where large acreages of sugar beet are grown? If you visit a farm in November, note how tops are always left a few days before feeding to animals. Sugar-beet tops contain small amounts of oxalic acid. When fed immediately, the acid causes severe scouring and sometimes death. The toxic effect of oxalic acid is reduced if the tops are allowed to wilt for a few days before feeding. Which other types of food should be fed with sugar-beet tops? Which is the most economical way of feeding tops to animals?

Sugar-beet tops may be made into silage. The pulp which is returned after the factory processing is also a valuable feeding-stuff. This is all that remains of the root after sugar and moisture have been removed. The pulp arrives back at the farm in a dry flaky condition. If you add water to dry sugar-beet pulp, watch how the substance swells out. Which crop is sugar-beet pulp most likely to replace on the farm?

Only the root portion of sugar beet will reach the factory. If you are able to visit a factory, you will notice that the roots are stored in large concrete hoppers. Water is sprayed onto them to remove dirt and stones. Next, the roots are cut into thin slices. These slices are exposed to hot water in order to extract the sugar juice. In the last chapter, this process was described in an experiment to demonstrate "osmosis". You will remember how a strong sugar solution always passes to a weaker solution. The extraction of sugar from beet is another example of how nature has set the pattern for a modern scientific technique. Of what importance is osmosis to all plants?

The raw sugar juice is refined by having carbon dioxide passed through it, and mixing with quicklime. After being boiled and concentrated once more, the first sugar crystals begin to form and grow. These crystals are passed into a granulator for drying and cooling before packeting. The used slices of beet are pressed and dried to remove moisture. The sugar-beet grower has first claim to the dried pulp. You already know the importance of sugar beet pulp in feeding to farm animals. How do farmers make use of the waste lime from sugar-beet factories?

Cut up a root of sugar beet and eat a small slice. Can you taste the sugar? The refined sugar obtained from cane or beet is correctly called "cane sugar". Dissolve a few grains of cane sugar in a test-tube containing water and two or three drops of hydrochloric acid, then boil. Add Fehlings solution and continue to boil for one minute. A brick-red precipitate shows the presence of cane sugar.

Finally, discover a few facts and figures about the sugar-beet crop. If the average annual yield is 4½ million tons, what is the approximate amount of beet handled by each of the eighteen factories in this country? If the crop yields 500,000 tons of white sugar, how many pounds is this per head of the population? Why does the Government encourage farmers to grow sugar beet at a time when there is a world surplus of sugar?

Further Reading

Sugar Beet by SYLVIA LAVERTON (LAND BOOKS: HUTCHINSON).
The Story of Sugar – BRITISH SUGAR CORPORATION, LONDON.
A Short History of the Sugar Beet Industry – B.S.C., LONDON.
Home Grown Sugar – B.S.C., LONDON.
Salt for Sugar Beet (I.C.I. PUBLIC.).

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Sugar Beet, Bulletin No. 153.
Sugar Beet Diseases, Bulletin No. 142.
Sugar Beet Pests, Bulletin No. 162.
Leaflets: BEET EELWORM (233); SUGAR BEET: SOWING TO SINGLING (122); SUGAR BEET: SINGLING TO DELIVERY (348); SILAGE FROM SUGAR BEET TOPS (354); SUGAR BEET PULP FOR FEEDING (363); SUGAR BEET TOPS FOR FEEDING GREEN (356); SUGAR BEET YELLOWS (323); SUGAR BEET HARVESTING (Farm Machinery Leaflet No. 17).

Chapter 3

Turnips, Swedes, Mangolds and Fodder Beet

Turnips, swedes, mangolds and fodder beet are all classed as root crops. These crops have carbohydrate stored inside their swollen roots, which are either completely or partly buried below soil-level. You already know potatoes supply us with easily digestible carbohydrates. In a previous experiment you found that the carbohydrates of the potato consisted mainly of starch. In root crops, about two-thirds of the carbohydrates consist of soluble sugars (glucose, sucrose, etc.). Animals are not able to utilize the sugars in root crops as efficiently as the carbohydrates of cereals, and consequently, the food value is reduced. Root crops normally develop only vegetative parts in the first year, with flowers and fruit in the second. How do they differ from annual crops such as cereals? What is the botanical term for plants living only two years? Root crops are generally harvested at the end of the first year, and the foodstuff in the swollen root is used for feeding to animals or man. Which other root crops are grown on the farm?

Swedes and turnips belong to the family of plants called Cruciferae. Several other important farm crops belong to this family, including kale, cabbage, rape and mustard. Plants of the Cruciferae are chiefly found growing in temperate and cold regions. The name "Cruciferae" comes from the flower which has four petals arranged in the shape of a cross. Most of the farm crops of this family are taken from the soil before flowers can develop, but you will be able to see the cross formed by the petals if you examine some of the many wild flowers belonging to the Cruciferae. Collect as many as you can find, identify them and make a list.

Many of our farm crops have a history of cultivation going back for hundreds of years. The turnip was grown by Greeks and Romans, but the crop is not thought to have been introduced to this country until much later.

Turnips are thought to have been first grown here in the middle of the sixteenth century. They were certainly being grown for sheep-feeding in the seventeenth century. In 1684, a book on animal husbandry was published which stated: "Sheep fatten very well on turnips which prove an excellent nourishment for them in winters when fodder is scarce; for they not only eat the greens, but feed on the roots in the ground and scoop them hollow even to the very skin."

A Norfolk landowner, Lord Townshend, was mainly responsible for introducing roots into the farm rotation. "Turnip" Townshend was able to demonstrate the value of root crops for feeding to sheep, together with the benefits received by the following crop in the rotation. So satisfactory were these demonstrations, that the Norfolk Four Course rotation quickly came into favour throughout the country. The original rotation of turnips, barley, clover and wheat formed the pattern of British farming for over a century.

Where swedes and turnips are grown, they form the cleaning crops in a rotation. Which crops are they likely to follow? Why are they called "cleaning crops"? The various root crops grown on any farm are collectively known as the "root break". There are some areas in Great Britain where swedes are grown in preference to turnips. Swedes are a hardier crop, and better able to withstand cool moist conditions. In which areas are swedes likely to occupy the root break? As you will read later, the methods of feeding are often different.

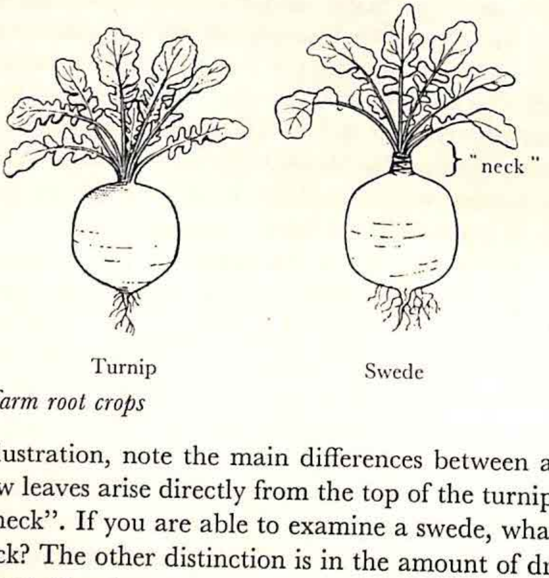


Fig. 27. Two farm root crops

From the illustration, note the main differences between a swede and a turnip. See how leaves arise directly from the top of the turnip root, but the swede has a "neck". If you are able to examine a swede, what scars do you find on the neck? The other distinction is in the amount of dry matter contained in the root. Turnips average 9 per cent and swedes 12 per cent. The dry matter contains the minerals, carbohydrates, proteins and fats, and swedes are more valuable for feeding to livestock. If both crops yielded 15 tons per acre, how much extra dry matter would come from a crop of swedes? In practice, do both crops have the same yield per acre?

Before sowing swedes or turnips, a farmer ensures that the seedbed is in the best possible condition. It is very important not to have an acid soil. How does the farmer ascertain soil acidity? How would you do it? Without an adequate supply of lime, swedes and turnips may suffer from the disease called Club Root (or Finger and Toe). The details of this disease are given later. It should be noted, however, that Club Root mainly occurs in acid soils.

A liberal application of a phosphatic fertilizer (e.g. 4 cwt. superphosphate per acre) is also important before sowing. Since good root development is dependent upon adequate supplies of phosphate, you will realize its value for all root crops. An average turnip crop removes 1½ cwt. of superphosphate per acre. What happens to the other 2½ cwt.? Why do farmers normally apply only ½ cwt. of nitrogen per acre to turnips? Which fertilizer is particularly necessary when swedes and turnips are grown on light chalky soils, subject to drought?

Lord Townshend was one of the first farmers to sow farm crops in straight lines. To do this, he used a drill invented by Jethro Tull (about 1730). "The drill is the engine that plants our corn and other seeds in rows; it makes the channels, sows the seed in them, and covers them up at the same time with great exactness and expedition." You will be able to see turnip and swede seed being sown by a modern drill during the months of May and June. Sowing is not always carried out on a level seedbed. If you live in an area of

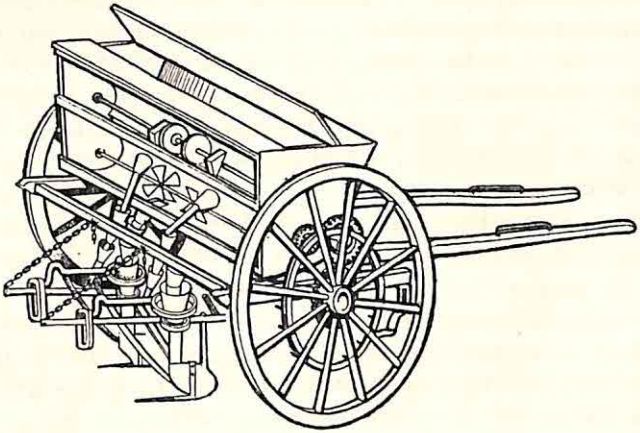


Fig. 28. Tull's seed drill

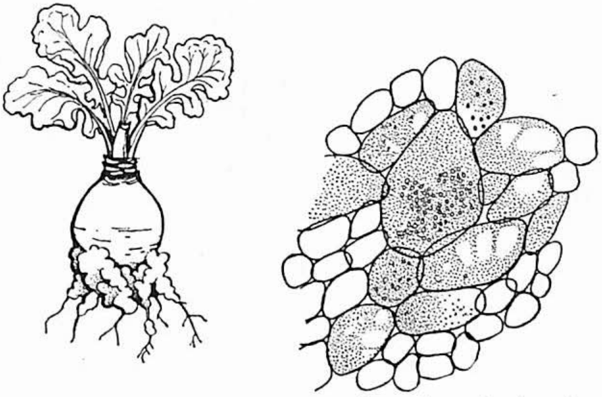
high rainfall, you may see root crops being sown "on the ridge". What is the main advantage of this method? In drier areas a normal flat seedbed is prepared. The row spacing is generally in multiples of 7 in. (14 in., 21 in. or 28 in.). Why is this? How is the normal seed drill adjusted for the sowing of root crops? You will know from your garden work how small are the seeds of swedes and turnips; only 4 lb. per acre are required.

Inter-row cultivations are commenced immediately seedlings appear above ground. The implements used today are very different from the horse-hoes popularized by Jethro Tull (1674–1740). During late June and July you will be able to see many different inter-row cleaners at work among root crops. Some will be mounted at the front of the tractor, others at the rear. If you watch these operations, note the different shape of the share at the end of each hoe. What will be the best type of tractor for inter-row work? Why is it so important for the driver to see the hoes from his driving seat?

During this early period of growth, the crop can be ruined by flea beetles. If you visit a field when seedlings are well established, search between the rows for small dark beetles. If you succeed in catching any, examine them carefully under a hand lens. Flea beetles are distinguished by specially enlarged hind legs for jumping. The best time to find this insect is in hot sunny weather. This is also the time when plants which have their seed leaves eaten are likely to suffer most. How does a good seedbed help plants to resist attacks from the flea beetle? What chemical can the farmer use to control this pest?

The crop is ready for singling when the first permanent leaves are formed. What name is given to the first pair of leaves to appear? If you grow swedes or turnips in the garden, leave part of a row unthinned. Observe the way the plants compete for light and soil food. When the crop is ready for lifting note the size and compare the weights of thinned and unthinned roots and the yields per yard of row. In the field, thinning of root crops is becoming more and more mechanized. You will remember from the sugar-beet chapter how "gapping machines" can reduce the number of plants to be thinned. There is still no real substitute for the final careful hand thinning. You may check the accuracy of this work by measuring the average distances between plants. Farm workers are usually paid according to the length of row satisfactorily thinned. This is called "piece-rate". The arrangement is welcomed by both the farmer and his men; work is speedily completed, and the men have a real incentive for hard work. Find out, if possible, the "piece-rates" for any particular type of farm work. By noting the time required to complete a task, it is possible to calculate the daily earnings of the men.

You will remember how important the seedbed preparations are in order to avoid Club Root disease. Test for soil acidity in a field where swedes and



Spore formation in cell

Fig. 29. Swede affected by "Club Root"

turnips are being grown. Any fields which are acid or waterlogged will be likely places to search for symptoms of Club Root. The disease is caused by a fungus which only attacks plants belonging to the Cruciferae. Can you find any weeds which have been attacked? You will see from the illustration how swellings form on the lower parts of the root. If you cut open these swellings, it is difficult to see the cause of the trouble. The cells have grown abnormally large, and it is only possible to see the spore formation in the cell by careful staining and examination under the microscope. During the latter half of the summer these swellings decay, and the small spores are liberated in the soil. Why is good drainage so important in the control of Club Root? What should be done to all diseased roots? What care should be taken if diseased roots are fed to farm animals?

If you find a small grub in root swellings, the injury is caused by the turnip gall weevil. The adult beetle lays eggs in spring. These are deposited in holes pierced in the root by the proboscis of the female. Examine swedes and turnips for signs of small rounded galls. If you are successful, carefully cut open a swelling so as not to damage the larva. Examine under a hand lens. Note the colour, and the position inside the gall. How does the larva escape from its chamber? Where does pupation take place? Has the farmer any use for an infected crop? Which other hosts can be used by this pest?

The turnip moth larvae may also cause damage. These are better known to the farmer as "cutworms". They are mainly nocturnal, and will only be seen during the day if disturbed. When a field of hay is being cut, the moth may be seen on the wing. You may be able to find eggs laid in flat clusters on the leaves. What will be the obvious food supply for the newly hatched larvae? Whenever you find seedlings of swedes, turnips or kale with small holes or stem damage, search in the soil near the plant for cutworms. They are greyish-brown, and grow to about an inch in length. Which other crops are likely to be affected?

Both turnips and swedes mature in the autumn. Before feeding, a farmer must first estimate the yield of his crop. If you visit a farm in the autumn, use the following yield table:

	WIDTH OF DRILL	
lb. per yard of drill	21 in.	28 in.
2 lb.	7·5 tons	5 tons
4 lb.	15 tons	10 tons
6 lb.	22·5 tons	15 tons

You will quickly realize that a good yield depends upon well-filled rows.

Turnips are normally eaten by sheep during the winter months. The flock is allowed to graze within a certain area, depending upon the estimated yield. This method of feeding is known by farmers as "folding". Why is it not possible to control the grazing area by an electric fence? What method of fencing is used with sheep? If you are able to watch sheep being folded, note how close to the ground roots are eaten. Many hill and wold farmers fold turnips and kale for the beneficial effects on light soils. Can you name these? Swedes are normally stored for a while in a clamp before feeding. The method of clamp building is given at the end of the chapter. How are swedes taken from the ground? Like mangolds, they are "topped" before leaving the field.

Turnips and swedes are called succulent foods because of their high water content. They fit well into winter rations, when most other foodstuffs are of a far drier or costive nature. As they are so digestible, roots are particularly valuable in feeding to sick or pregnant animals. How is this made use of in folding sheep on turnips?

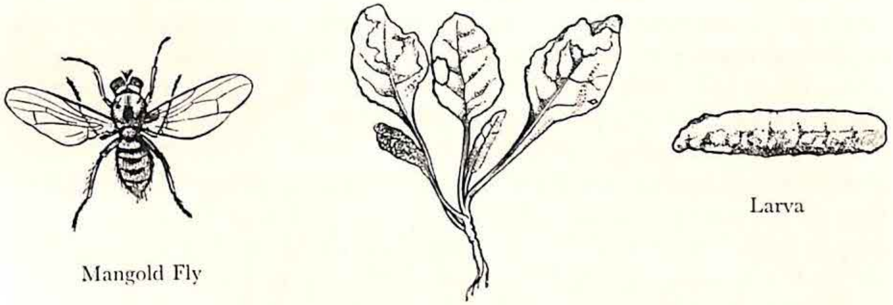
MANGOLDS AND FODDER BEET

Mangolds and fodder beet are both root crops, and belong to the *Beta* genus of the Chenopodiaceae family. The *Beta* genus is thought to have originated on the sea coasts of Southern Europe; there are now many varieties with varied root characters. Both root crops are remarkably free from disease, and may be grown on the same land year after year. Mangolds were introduced into British farming when turnip growing was already widespread.

Today, mangolds are grown mainly in eastern and southern districts—perhaps you can suggest why?

Compare the root of the mangold with a swede or turnip. Note the differences in colour and size. Measure the length of root which is normally below soil-level. This will indicate why mangolds are better able to withstand the dry climate of the South and East. At maturity, mangolds provide a much higher yield than turnips or swedes. If the average yield is 25 tons to the acre with 12 per cent of dry matter, how much dry matter can be expected per acre? Compare with your previous estimates for swedes and turnips.

Mangold and fodder-beet seed are supplied to the farmer in cluster form. How is this cluster of seeds formed? Which other farm crops form similar seeds? In the seedbed preparations, which special fertilizer may be applied to members of the *Beta* genus?



Mangold Fly

Leaf damage

Larva

Fig. 30. Stages in the life history of a mangold fly

Sowing, inter-row cultivation and singling are carried out in a similar way to that used with turnips and swedes. If you visit a farm where singling has recently taken place, search among plants for any which have dropped over, or have blotches on the leaf (see illustration). You may remember from the sugar-beet chapter which pest is responsible—the mangold fly. Search the under surface of leaves for small oval eggs. If the eggs have already hatched, open the blistered portion of the leaf and examine for white larvae. Where is pupation likely to take place? What advantage results from the laying of eggs on the underside of the leaf? Where damage is serious, a poison bait is applied across strips of the field. Birds eat many of the larvae. Starlings in particular help to keep the pest under control.

Pull up a number of mangolds and select three or four which have approximately the same root length. Carefully strip off the leaves, and calculate the total area in square inches (as with cabbage and rape). Do you find that the plants with most leaf-area develop the heaviest roots? Try to account for your findings. Cut open the root and examine under a hand lens. Can you distinguish a number of indistinct rings radiating from the centre? What are these? Note the small root hairs coming from the lower part of the root. What is the botanical name for this type of root?

You will see mangolds and fodder beet being lifted during October and November. Mechanical lifters may be used when the acreage is sufficiently large. Why is it important to have mangolds out of the ground before December? When tops are removed, the same care has to be taken as with garden beetroot. What happens if tops are cut off? How are the tops of mangolds removed in the field? After being left on the surface for a day or two, roots are transported away by tractor and trailer for storage in a clamp. The clamp's construction is similar to that of a potato clamp with the addition of ventilation shafts. How is frost damage avoided? Why are ventilation shafts necessary? Mangolds are placed inside a clamp to "ripen". When lifted, mangolds contain between 7 and 8 per cent "crude" protein. Crude protein cannot be properly digested, but during storage inside a clamp, a more digestible protein is formed.

Swedes and turnips are fed to animals and man. Mangolds and fodder beet are fed only to animals. After storage, mangolds and swedes are usually pulped before use. This is of special importance in the feeding of young livestock. A calf would obviously find great difficulty in trying to eat a whole mangold root. A sheep, on the other hand, has no difficulty in eating a turnip. How do the teeth of a cow differ from those of a sheep? Although root crops are often fed to farm animals, they are not very rich in food value. They do, however, supply winter food in livestock areas where it is not always possible to grow other crops.

Further Reading

Y.F.C. Publications (EVANS BROS.):

Arable Crops 1 by J. O. THOMAS.
Garden and Farm Insects by A. J. A. WOODCOCK.
Preserving Crops for Wintering Stock by M. L. YEO.
Sheep Farming by W. R. SEWARD.

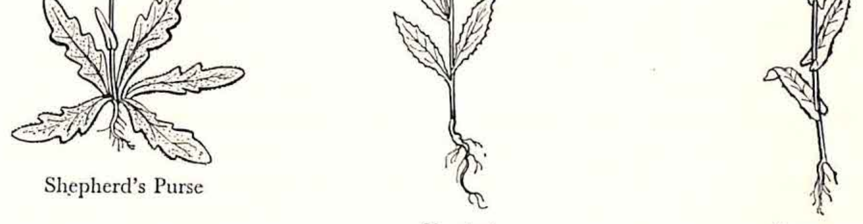
Ministry of Agriculture Publications:

Leaflets: MANGOLD FLY (91); TURNIP GALL WEEVIL (196); BEET EELWORM (233); FODDER BEET: FEEDING VALUE AND PRACTICE (403).

Chapter 4

Kale, Rape and Field Cabbage

Kales all belong to the Cruciferae family. There are many well-known plants in this order including watercress, wallflower and the wild varieties of cabbage and turnip. The Cruciferae have a uniform flower structure, alternate leaves and no stipules. Most hedgerows and roadsides contain a number of these plants. You should have no difficulty in collecting specimens of charlock, pennycress, shepherd's purse and Jack-by-the-hedge. Note the two main types of seed case developed by the Cruciferae. Which other plants develop similar capsule fruits? How do the seeds escape? Look at the seed arrangement inside the case.



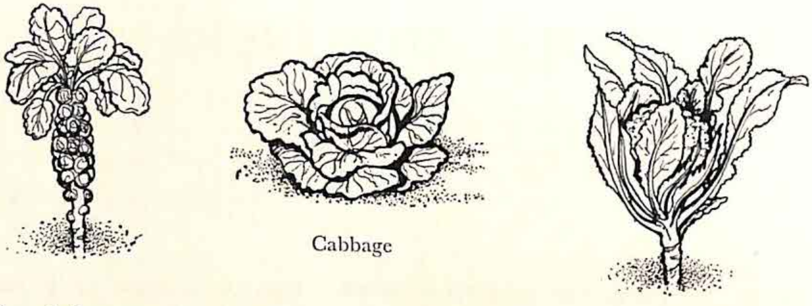
Shepherd's Purse

Charlock

Pennycress

Fig. 31. Common hedgerow Cruciferae

In order to classify the large number of plants in the Cruciferae order, they are subdivided into various groups according to flower, seed and fruit characters. The *Brassica* genus which includes turnips and swedes has already been dealt with in the last chapter. The species *Brassica oleraceae* is the wild cabbage, from which our cultivated cabbage, brussels sprouts, broccoli, cauliflower and kales have been developed. The wild cabbage is thought to have originated on the Mediterranean coast. You may be able to find specimens of wild cabbage on your holidays. It is a plant quite common on some parts of the coast of this country.



Brussels Sprouts

Cabbage

Cauliflower

Fig. 32. Useful members of the Cruciferae family

Long before kale was grown for cattle food, it was a popular garden vegetable. What is the gardener's name for kale? Which varieties are still grown for human consumption? The Common or Scotch kale used to be grown in the gardens of the crofters, which were called "kail yards". The lower leaves were stripped off and used in the preparation of a popular broth. This plant was superseded by a German variety of kale growing to a height of 4 ft. In the Channel Islands, a similar plant was cultivated which, it is claimed, grew to 12 ft. The fact that kales can produce such tremendous growth makes this plant one of the main foods for dairy cattle today.

Almost all the kale grown in this country is the marrow-stem variety. If you are on a farm walk in autumn, measure the height of the tallest plants. It is difficult to realize that marrow-stem kale was produced by crossing two very much smaller varieties of kale. The first of these is still grown in parts of southern and eastern England, and is known as kohl-rabi. If you examine this plant, notice how the stem swells up just above ground-level in order to store food. Why is this type of kale cultivated mostly on the eastern side of England?

The other parent of marrow-stem kale was thousand-headed kale. Marrow-stem kale was bred by combining the stem food-storage characteristic of

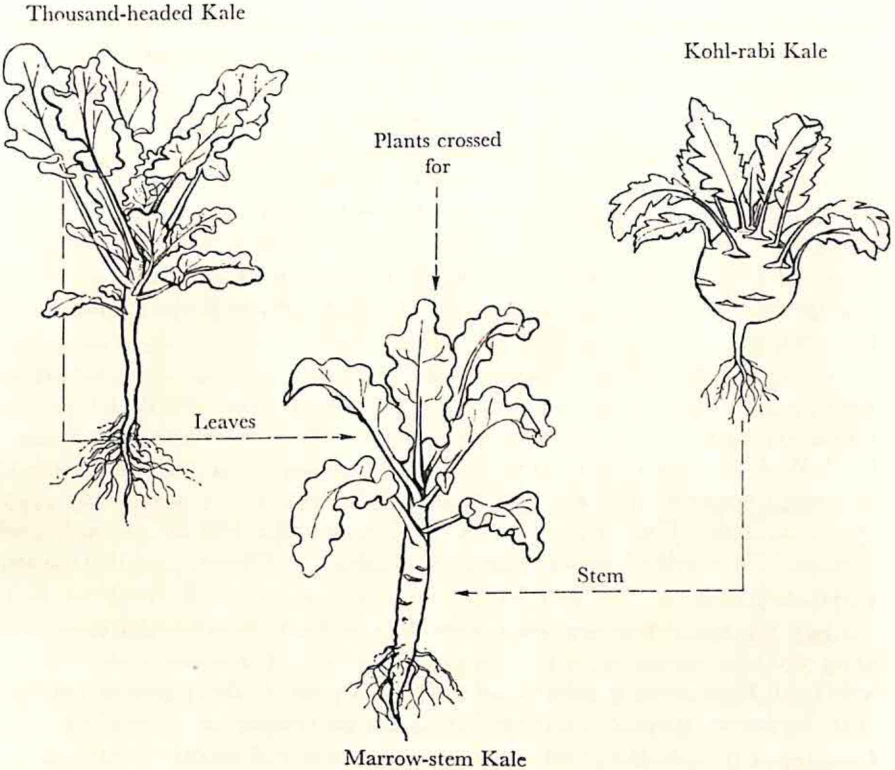


Fig. 33. Parentage of marrow-stem kale

kohl-rabi with the leafy growth of thousand-headed kale. If you are able to examine marrow-stem kale, you will see how two good plant qualities have been combined to produce one plant of outstanding value to the farmer. You may like to grow a row of each of these plants in the garden for interest, and even try to repeat this cross. Which other types of kale are grown on farms?

In agriculture, kale is classed as a forage crop. Plants under this heading are consumed in the green state by livestock. Make a list of forage crops which are grown in your area. Opposite these names enter the time of year when they are fed, and to which animals. You will note that many of these plants belong to the Cruciferae order. Which other plant order contains many of the forage crops you have written down? How many wild flowers can you name belonging to the second order?

During the past twenty or thirty years kale has become one of the most important crops grown in this country. It is rare to find a dairy farm without a few acres. Which previously grown forage crops has kale replaced? In the farm rotation kale replaces part or all of the root break. The cultivations required are similar to those for the growing of swedes and turnips. For maximum yield all Brassica crops require one particular fertilizer more than any other. Which plant food is essential for all crops which are grown mainly for their foliage? Farmyard manure, when used, is ploughed in during the previous autumn. The rest of the fertilizers are applied prior to the sowing of the seed. This generally consists of 2 cwt. of sulphate of ammonia, 4 cwt. of superphosphate and 1 cwt. of muriate of potash. What is the fertilizer bill per acre?

Can you distinguish kale seed from cabbage or swede? As the seeds are so small, what type of seedbed must be prepared by the farmer? Which implements are used for this purpose? How does the farmer ensure a firm seedbed? With normal drilling, only 5 lb. of seed per acre will be required. Marrow-stem kale will yield up to 30 tons per acre, which is 6 tons for each pound of seed. Find the seed rate/yield ratio of mangolds, swedes and turnips. When kale plants are raised in a seedbed and transplanted, a pound of seed will provide an acre of kale.

Once the seed has germinated, growth is rapid. During several visits to a farm you may measure the growth of selected plants in various parts of the kale field. How is the growth of kale affected by the shade of trees or hedges? Has the farmer thinned the crop? If not, ask his permission to thin part of a row. Leave a number of plants spaced 9 in. apart and others, 18 in. During later visits, compare the heights of the thinned and unthinned kale. When the kale has matured, compare the different plant weights. How much extra tonnage per acre would the farmer have obtained if all the crop had been thinned?

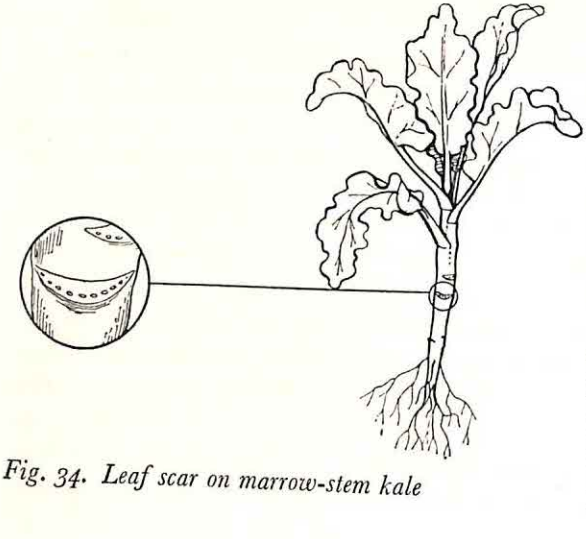


Fig. 34. Leaf scar on marrow-stem kale

Marrow-stem kale reaches maturity during late autumn. This is the best time to make a detailed examination of the plant. You will note that the central and lower stem is devoid of leaves, with large leaf scars marking the place where they were once attached. Count the number of leaf scars on a few plants. Does the number increase with the height of the plant? Account for the falling of the leaves. Examine the scar with a hand lens. Can you find the leaf bud? Which tree leaf scar does this remind you of?

You will find that the stem is narrow at ground-level and increases in diameter towards the top. Carefully cut a 6 in. section from the thickest part of the stem. Note the thick outer skin. What is the botanical name for this protective cover? How much of the stem is pith? Remove this juicy material and allow the hollow stem to dry out for a few days. Examine with a lens and observe how the cork layers harden and fold over towards the centre. If there is a leaf scar on this section of stem, you will now be able to peel away the whole of the cork cover. What function does this material fulfil? You may also carry out the test for leaf area as described for rape and cabbage. How does this leaf area affect the growth of weeds?

If you are able to watch cattle grazing kale, you will notice that the leaves are always eaten first. With marrow-stem kale, a cow will also eat away a portion of the top stem, depending on the age of the plant and the number of plants available. If too much food is available, the stem containing the nutritious pith will be ignored and so wasted. Other varieties of kale such as thousand-headed, and hungry-gap have a more leafy attraction for cattle and are grazed closer to the ground. Neither of these two kales is affected by frost, but marrow-stem is, and must be fed before January.

The most common way of feeding kale is by "strip grazing". Each day a certain area of kale is made available to cattle. The area boundary is generally controlled by an electric fence which must be adjusted daily by the farmer. Cattle soon learn not to go too near this electrified wire. How can you test that electricity is passing through the wire without getting a shock? Find out how an electric fencer works. In order to strip graze, a farmer has to be able to calculate how many hundredweights of kale are available in a certain area. A large breed of cow such as a Friesian is able to eat 1 cwt. of kale per day. Measure off a square yard of kale. Weigh the parts of the plant which are likely to be eaten by the cow. From your results estimate the area in square yards to be made available daily to a herd of fifteen Friesians. The Channel Island breeds of cow must have their intake of kale restricted in order to leave room for the essential concentrate foods fed at milking time. Which foods are these? Which other crop may be sown in the kale to make strip grazing easier?

There are other ways of feeding kale besides daily grazing. The method often depends on the type of soil. If you are able to walk across a recently grazed field, note the amount of wasted kale stalks. Has the field been churned up by the action of the cows' feet? Does this have any adverse effect on future crops? Does it cause harm to the cow to stand knee-deep in mud? All, or any of these factors may induce a farmer to find an alternative method of feeding.

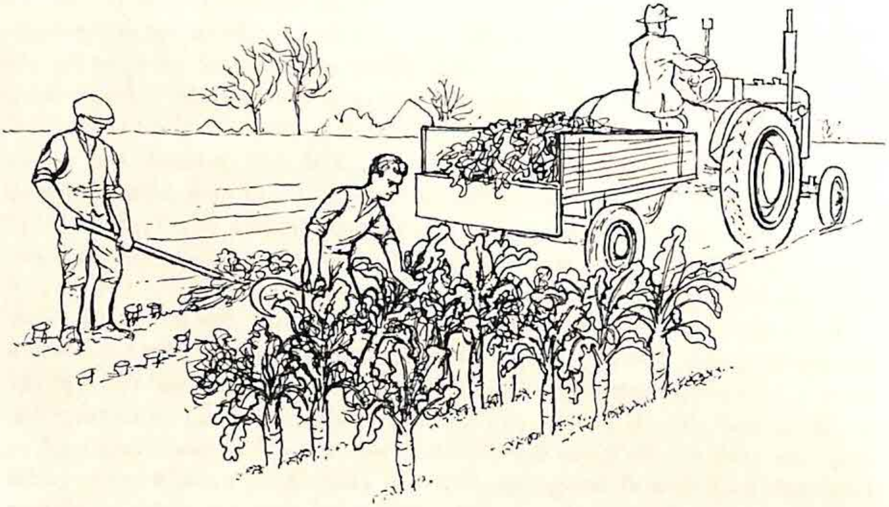


Fig. 35. Hand cutting and carting marrow-stem kale

Some farmers prefer to cut the kale by hand and load the crop into a tractor and trailer. The stalks are either fed to animals in yards or thrown out to them on a grass field. What is the main disadvantage of this method? A green-crop loader will do the same job much more quickly. Both methods ensure that the kale plant reaches the cow, but the stem of the plant is still often wasted. A forage harvester—the machine which cuts grass and chops it up at the same time—may be used to make kale silage. Both the stems and the leaves are converted into small pieces of food. After storage in a clamp, kale silage is as digestible as ordinary grass silage.

Approximately 86 per cent of the kale plant is water. Of the remaining 14 per cent, 9·4 per cent is carbohydrate, 2·2 per cent protein, 1·9 per cent ash and 0·5 per cent oil. You already know that a Friesian cow may eat 112 lb. of kale per day. Calculate the number of pounds of carbohydrate, protein and oil eaten daily. Each gallon of milk produced by the cow requires 2½ lb. of starch or carbohydrate and ½ lb. of protein. If all the foods contained in the kale plant are digestible, how many gallons of milk are made from 112 lb. of kale? Why is a milking cow always fed more than its production ration?

RAPE AND FIELD CABBAGE

Rape is a crop which is generally fed to sheep. It looks very similar to a swede, except that it has no swollen root. Rape belongs to the *Brassica* genus, as do cabbage and kale, and is a biennial.

Rape is often used as a catch-crop. This means that the seed may be sown immediately after another crop has been removed from a field. In this way, a farmer is able to provide an additional forage crop for his sheep. Which farm crops are harvested sufficiently early for rape to be sown immediately afterwards? In which countries is it always possible to harvest two crops each year?

When grown as a main crop, rape will occupy the place of roots in the farm rotation. Sowing is completed by the end of April and in twelve or fourteen weeks the crop is ready for grazing. Because of this rapid growth, there is little competition from other plants. How does the farmer make use of this? Which other crop also smothers its competitors? Most leafy plants which grow so rapidly rely on photosynthesis for much of their food. This fact is not always fully realized by the farmer. If you know a field where rape is grown, measure the height of a number of plants during July. You will see that the taller plants possess more leaves than the shorter ones. What happens when the crop is grazed before the plant has time to develop many leaves? What should be the minimum height before grazing commences? Rape may also be used instead of a cereal as a "nurse crop", when land is being sown with grass seed.

Select a row of rape and measure the height of the plants. Strip all the leaves off two plants. Leave just a few leaves on the next two, and continue until the last pair of plants are allowed to grow untouched. Measure the growth rates after a week or ten days. What do you find? Where do the leaves form on the completely stripped plants? Is it possible to kill the plant by removing each leaf as it forms?

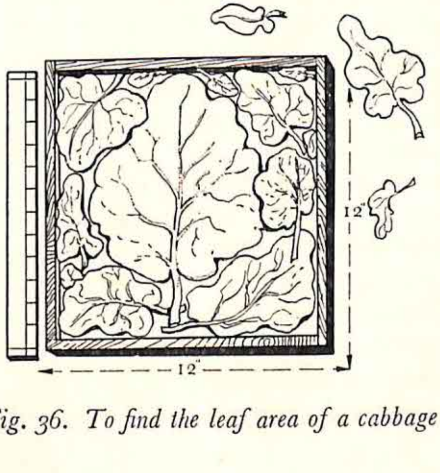


Fig. 36. To find the leaf area of a cabbage

Cabbage grown for cattle feed receives cultivation similar to that of kale. Again the food value is in the leaf, but there is very little stem wastage. The species of cabbage is usually of a coarser type than that grown in gardens. The yield may be as high as 30 tons per acre.

Cut through the centre of a cabbage. How does the colour change from the outside to the centre? Why? Can you find the flower which would have bloomed in the second year? Measure four thin strips of wood and make them into a square the inner sides of which are 12 in. long. Carefully peel off each layer of leaf from a weighed cabbage, measuring the area inside the wooden frame. Use small or torn leaves to complete the square. How many square inches of leaf are contained in the cabbage? Use this method for leaf counts with rape and kale. How does the area vary with the same weight of each crop?

The leaves of kale, rape and cabbage provide cover for several species of insects. On which side of the leaves are these insects to be found? What process is carried out only on the underside of the leaf? Place a leaf under a tap, allow water to run over the surface and examine. Is the leaf wet? How is it possible to spray these crops and ensure that the leaves are thoroughly wetted?

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Farm Implements by H. J. HINE. Y.F.C. PUBLICATION (EVANS BROS.).

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Chapter 5

Field Beans

Beans were one of the first crops to be cultivated by primitive man. Some of the earliest bean specimens have been found by geologists excavating Swiss lake dwellings, and thus date from the Bronze Age. These beans were so small and round that geologists at first mistook them for peas. Similar specimens were also found during the excavation of lake dwellings in Somerset. In the Bible, we read in the Book of Samuel how David brought "flour and parched corn and beans . . . for the people that were with him to eat". Clearly beans have been cultivated ever since man turned from hunting animals to lead a pastoral life.

Both peas and beans belong to the Leguminosae order of plants. This order contains a great number of flowers, trees and herbs, together with the very valuable clover and vetch genera. How many wild and garden flowers can you name belonging to this order?

Both peas and beans are grown for the high protein value of their seeds, which is twice the amount found in wheat. You can test for this protein by cutting a bean up into small pieces and grinding with a mortar and pestle. Add Millon's Reagent and heat gently. A brick-red colour will show the presence of protein. Leguminous plants which are grown for their seed are known as 'pulse crops'. All pulse crops have small swellings called 'nodules' on their roots. The bacteria inside the root nodules help to maintain the 'nitrogen cycle'. Nitrogen is continually being interchanged between the soil and the air. The root bacteria are able to feed on nitrogen in the air circulating between the particles of soil, converting it into plant protein. The plant residue after harvest is rich in protein, and some is returned to the air as a nitrogen compound (ammonia). The nitrogen cycle is now complete. Dig up a root of clover, pea or bean and find these root swellings.

Beans grown on the farm are either of the Winter bean variety, or else the Spring "tick" or horse bean.

Seed is sown at the rate of approximately 200 lb. per acre. Weigh out and

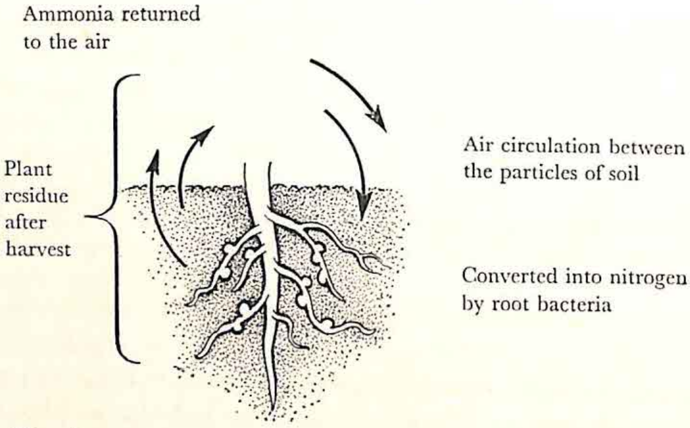


Fig. 37. The nitrogen cycle

count the number of beans making up an ounce or a pound in weight. Calculate the number of beans sown per acre. If a good crop will yield 1 ton of grain, what is the exact seed : yield ratio? Keep some of this seed for the next experiment.

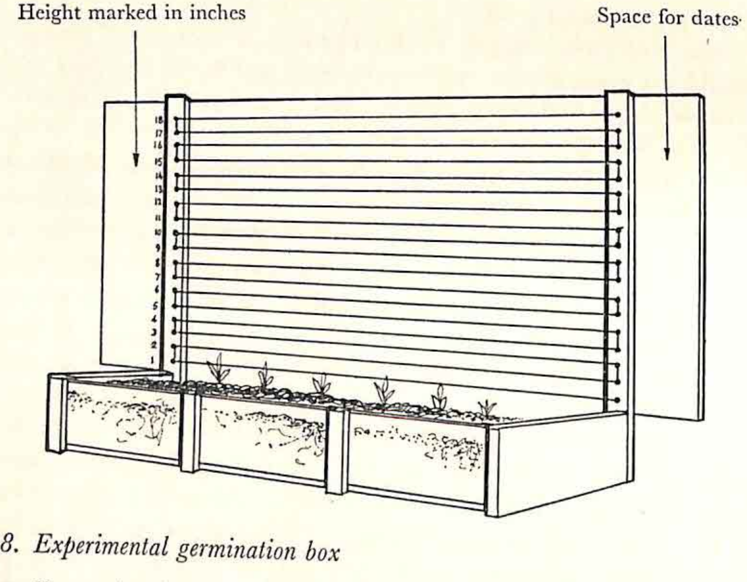


Fig. 38. Experimental germination box

A small germination box (see illustration) can easily be constructed. The strands of cotton should be exactly 1 in. apart, and may be held in place by small nails or drawing pins. A large sheet of white paper is pinned to the two uprights, allowing an extra inch each side. One side of the sheet should be marked in inches. The space on the opposite side is for inserting the date when each inch of growth is recorded. The various varieties of beans may be used in different types of soil. When dark paper is placed over the glass, each stage in the process of germination may be observed.

In the farm rotation, beans often take the place of roots on clay soils. Beans may also replace the clover break, in which case the following crop is generally wheat. Why is this? Why are no fertilizers applied when beans follow a ley? After a cereal crop, farmyard manure is often ploughed in during the autumn. One or 2 cwt. of muriate of potash and superphosphate will be applied to the seedbed. If possible, this fertilizer should be "placed" near the seed. It is worth noting that John Worlidge in 1669 described a drill for sowing compost and seed at the same time. It has taken three hundred years for agriculturalists to realize fully the advantages of a drill which distributes fertilizer as well as seed.

Beans are the largest seeds sown on British farms. Partly because of their size, it has never been very practicable to distribute them by hand onto the seedbed. Until quite recently, beans were sown by pushing a small wheeled hopper between the furrows. This would space seed ready for covering by the next furrow which the plough turned over. A similar hand drill was in use by the Chinese in 2800 B.C. Today the hopper is often attached to the plough beam so that ploughing and sowing may be done at the same time. From 1700 until 1200 B.C. the Babylonians used a drill plough. Progress can often result from the reading of history books. When land was too wet for sowing, long hand dibbers were used to make holes for the seed. Where are beans still sown today with the aid of a dibber?

Most of our farm beans are now sown by the force-feed drill. If you are on a farm walk, measure the distance between the rows. How deep were the seeds placed? What is the average number of plants per foot of row? For a good yield, a large number of plants per square yard is required. The row spacing is important as it allows inter-row cleaning to take place. What implement will be used for this purpose?

Beans which have been sown in the autumn will come into flower in early May. The smaller "tick" beans—which look like the canned baked beans—flower about a month later. The time of flowering is very important. The yield of the crop will largely depend upon what happens whilst the bean is in flower. For proper pod formation, each flower must be fertilized. What does this involve? Years ago, fertilization was accomplished by bumble bees and colonies of wild bees. Why is this not always possible today? Few farmers, unfortunately, realize that without bees they will rarely get a good yield of beans. When bees have been enclosed in cages with flowering beans, the yield is often doubled. Watch bees at work on bean flowers. Notice whether any flowers are "robbed" without pollination being effected. If possible, place fine meshed nets round a number of bean plants in bud, to prevent the visitation of insects. Only remove the nets when the flowers have died away. Do you obtain the same yield?

When a large number of plants of the same type are grown together in the field, all pests and diseases spread more quickly. During June, most gardeners nip off the tops of broad beans to control any aphid infection. You will realize how impossible is this task in a 5–10 acre field. The farmer may decide to control black fly by spraying. Sprays, however, are not altogether selective in the killing of insects. What problem will this present to the farmer? Who is available to give the expert advice now required?

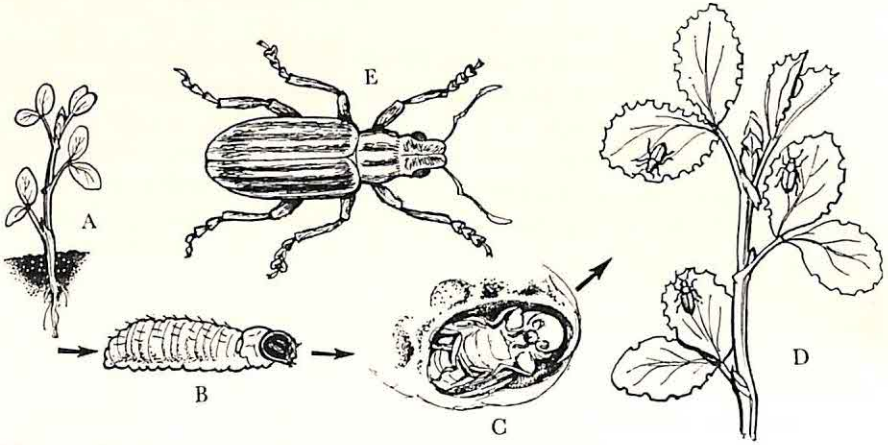


Fig. 39. Stages in the life history of the pea and bean weevil
(a) Eggs laid in soil *(b) Larva* *(c) Pupa* *(d) Leaf damage* *(e) Adult weevil*

You should have little difficulty in finding weevils living in a bean crop. You will recognize them as beetles, but with a long snout, and curved antennae, clubbed at the end. Collect a few leaves showing where they have been eating. At what stage in the life of the bean will damage be greatest? Weevil eggs are laid in the soil. After the eggs have hatched, what will the larvae feed on? How is the bean plant damaged? What can the farmer do about this? If you dig around a few bean stalks, you may find these white wrinkled larvae with brown heads. Examine with a hand lens. How does each segment assist movement through the soil? Find the strong biting jaws. Keep some larvae in a cool box with plenty of damp soil and the fresh roots of peas and beans. What happens in a few weeks? How does the weevil pass the winter?

Most bean crops carry symptoms of the fungus disease Chocolate Spot. Fungi contain no chlorophyll, and rely on the host plant for a ready-made supply of food. Gather a few leaves which have the characteristic brown spots and mount under a high-powered microscope. What do you see? What type of weather causes all fungal diseases to spread more rapidly? Which fields are most likely to carry this disease?

When bean plants are found dead in the row it may be a symptom of Stem Rot. Examine for rotting at the base of the stem. As clover may also carry this disease, why is it unwise to grow the two crops too close in the rotation?

Beans are ready for harvesting when the leaves have turned black and fallen to the ground. If you open one of the pods at this time, note how the hilum, or point of attachment to the pod, is also black. Before ripening, you will have noticed the soft white woolly lining of the green pods. Gather a number of pods in various stages of maturity. The soft lining disappears as maturity is reached. How would the seeds be dispersed if the pods were left on the plant?

Carefully cut through one of the mature plant stems. What is the shape of this stem? How does it differ from that of the pea plant? Dig out one or two roots. What type of root is it? Find out the length of the stubble left behind after harvesting. The stem, leaves and the root all add valuable organic matter to the soil when they are ploughed in.

Beans may be harvested with a binder or combine harvester. The binder—now fast disappearing from our farms—cuts the crop and binds it into sheaves. These are put up in groups of 8 or 10 to form stooks in the field. The grain hardens in the stooks. After a few days, the sheaves are carted away and stacked. The hardened grain is removed by a thresher three or four months later. The combine harvester does the same work in one operation, but the straw is left in the field.

You will remember from the first chapter that protein and starch are essential foods for animals and man. The ratio of starch to protein varies according to the age and function of the animal. In milk production, for example, approximately five parts of starch are fed with one part of protein. Beans supply much of the protein required in animal rations. The protein is required for the building up and replacing of body tissues. During what period in an animal's life is it essential to feed a high proportion of protein? What happens to surplus protein in the body?

Beans have a protein value of 19·5 per cent which is equal to imported palm kernel cake. Before being fed, the grain has to be crushed or ground up

Fig. 40. Grinding corn in Neolithic times

into a powder. We know that in Neolithic times grinding stones were associated with the burial of women; clearly it had been their task to manoeuvre these stones and crush the grain. The machine which does this today is called a hammer mill (see illustration). Most farms possess one of these machines.

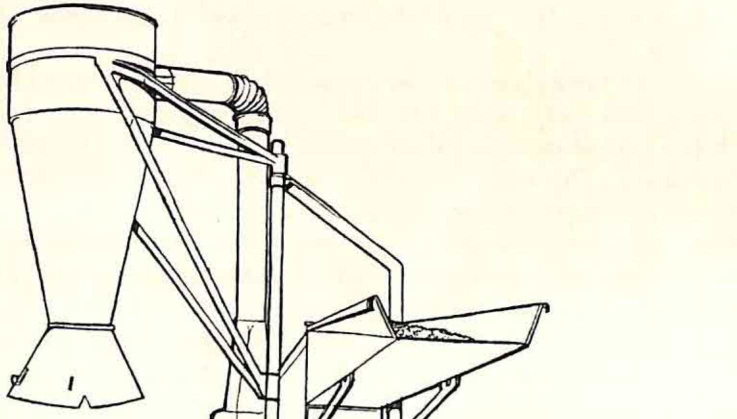


Fig. 41. A hammer mill

Detail of crushing mechanism

You will see that the grain is stored in a large hopper. Entry into the inner chamber is controlled by a feed adjustment. Inside the chamber, grinding is carried on by hammers which rotate at great speed. The meal passing through the sieves at the bottom of the chamber is sucked along in a cyclone created by a rotating fan. What is the cost of a small hammer mill? Which types of grain are passed through this machine?

Beans for canning, such as "baked beans", come mainly from the U.S.A., Eastern Europe and Chile. The pods are harvested and dried, and the beans arrive in this country as small, hard, pea-shaped grains. Before cooking and canning, each bean is examined by an electronic eye to check for quality. Tomato sauce is added before canning. Baked beans possess the same valuable protein as the British field bean.

Further Reading

Ministry of Agriculture Publications:

Field Beans by H. R. SOPER, M.A.

Leaflets: PEA, BEAN AND CLOVER LEAF WEEVILS (61); PEA AND BEAN THRIPS (170); PEA AND BEAN BEETLES (126); BLACK BEAN APHID (54); HAMMER MILLS (Machinery Leaflet 20).

Chapter 6

Field Peas

The growing of peas for food goes back as far as recorded history. Both peas and beans have been found during excavations of cave dwellings. The primitive people living in these caves were not particularly "house-proud", and the rubbish which accumulated on the floor shows quite clearly the type of food eaten at that time.

The lentil is another very old member of the pea family and is still grown today. You may have read in the Book of Genesis how Jacob gave Esau "bread and pottage of lentils". Lentils are grown extensively in Syria and Palestine, as the plant will thrive on ground unsuitable for other seeds. Our split peas resemble the lentil. The two small hemispheres are the same shape as a magnifying glass. You will now realize the derivation of our word "lens".

The common or grey pea found growing wild in Greece is the origin of all our domestic species of pea. Careful selection and plant breeding has enabled the gardener and the farmer to obtain the many varieties of peas grown today. It has been found possible to grow a variety of pea which has an edible pod. What name is given to this variety? You will remember from the previous chapter how peas and beans are both members of the Leguminosae order of plants. What important natural advantage have peas and beans over non-leguminous crops? Have you noticed, for example, how gorse will become established on heaths and commons where little else will grow?

Bake some soil in a tin to kill all the micro-organisms. Grow a few peas in this soil. Examine the roots carefully for nitrogen bacteria swellings. What has happened?

In terms of cash value, peas come next to potatoes in the list of vegetable farm crops. Improved methods of harvesting and processing have recently led to a big increase in the acreage of peas grown. In this country, there are two main types of pea grown on the farm: (*a*) Marrowfat; (*b*) Blue Round peas.

The marrowfat varieties are far superior in quality and make up most of the supplies going for canning and freezing. Where peas are grown for very early marketing, the smaller and hardier blue round varieties are used. Note the varieties of garden pea for sale at your local seed merchants. Which type are they? Like the gardener, the farmer chooses a variety of pea which is known to grow well in his district.

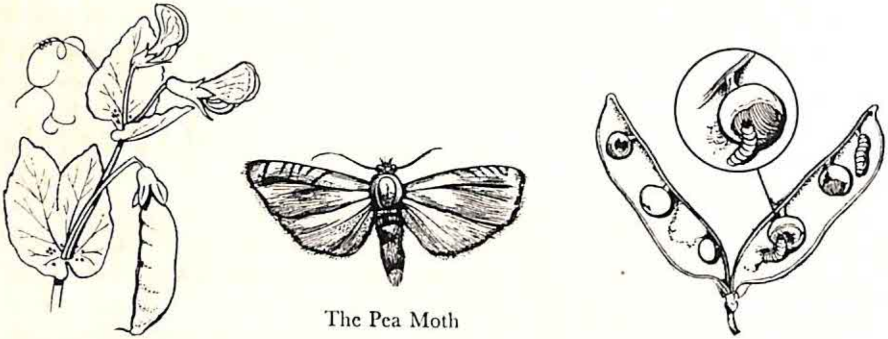
Before deciding to grow peas, a farmer must make sure he will have sufficient labour available for harvesting. When green peas are grown for market, large gangs of casual labour will be required for field picking. Peas fit easily into almost any farm rotation. They may follow root crops, vegetables or cereals. As peas are susceptible to eelworm attack, they should not be grown in the same soil more than once every four years. What other leguminous farm crops are also liable to attack by the pea root eelworm? Which farm crops may be attacked by other types of eelworms? You will also know how all the pulse crops leave behind a valuable supply of nitrogen.

Try to obtain a sample of the peas that a farmer intends sowing. Find the point of attachment to the pod of a healthy pea. Carefully remove the seed coat and find the radicle. Press the pea in your fingers to separate the halves. What is the name of these pieces? What is their use during germination?

The seedbed preparations are designed to give a fine tilth and the best possible aeration of the soil. The important root nodules of the pea must have a plentiful supply of nitrogen from the air. What type of seedbed would prevent the formation of root nodules? The average seedbed application of fertilizer per acre is 4 cwt. of superphosphate and 1 cwt. of muriate of potash. The farmer will check the fineness of the tilth with his boot. The method is to push the side of the boot into the soil and move away a few inches of top soil. If the exposed soil is too lumpy, the farmer will arrange for the cultivator or harrow to work over the field again. If the tilth is suitable, it is possible to begin sowing from the end of February.

Peas are usually drilled in rows approximately 15 in. apart. The ordinary seed drill is used without fitting all the coulters. If you are able to watch peas being drilled, notice how the farmer will avoid drilling along the paths being made by the tractor. Any such sowings will result in inferior plants. Why is this? How can the wheels of a tractor be adjusted for minimum pressure on the ground? Depending on the width of the rows, 1 to 2 cwt. of seed will be required per acre. Weigh out a small quantity of the seed (as described in the bean chapter) and determine the number of seeds sown per acre. After germination, take a number of plant counts throughout the field. What proportion of seed was wasted? Regular observation would enable you to account for this.

Field peas take between 12 and 18 weeks to mature. This time will depend on the use to be made of the crop; green peas for market will be removed much earlier than peas for harvesting dry. During this period of growth peas are liable to suffer from a number of pests and diseases. You will be able to recognize damage caused by the pea and bean weevil from the description already given in the bean chapter. The pea aphid (greenfly) can often be found on plants during May and June. Which part of the plant is likely to be damaged? Damage can be halted by an application of a D.D.T. spray.



The Pea Moth

Eggs laid in
base of stipule

Larvae damage
inside pod

Fig. 42. Stages in the life history of the pea moth

The most serious pest of field peas is the pea moth. The moth is grey-brown in colour, with a wing span of $\frac{1}{2}$ in. You will be able to see these moths on most warm days between mid-June and mid-August. The best time to search for eggs is in mid-July; carefully examine the leaves and stipules for small flattened eggs. These may be laid singly or in groups. Dig out the plant taking care not to dislodge soil from the root. Re-set where you can observe it. How long do the eggs take to hatch? Which part of the plant do the larvae make for? How long does the larva remain inside the pod? When it is fully grown, note how the grub cuts another hole in the pod before descending to the soil for pupation. Can you complete the life cycle of the pea moth?

A carefully timed spray of D.D.T. will reduce damage.

The pea and bean thrips are better known to you as "thunder flies". These small creatures which irritate you during hot sultry weather, annoy the farmer for a very different reason. Search among pea flowers during June for small orange-yellow larvae. Use a hand lens to examine one carefully. You may find the larva feeding on a minute drop of liquid. This drop of moisture is formed by the larva scraping away at the plant tissue. After three or four weeks of feeding, the thrips descend to the soil where they remain until they become mature the following spring.

Peas grown in the garden are generally given stick supports when they are a few inches high. This is not possible with field peas. The 15 in. space between the rows is generally filled up as the pea plant spreads outwards instead of upwards. As you already know, the leaf of the pea plant is extended to form a climbing support known as a tendril. Tendrils are really modified leaves and very sensitive to contact. If you examine a plant with young tendrils notice the hook at the end. Gently rub the inside of the hook with a pencil point. What happens? Find the well-developed stipules at the base of the leaf. What is their function? Which other plants develop them? How does the plant stem differ from that of the bean?

Peas are self-pollinated and do not rely on the visits of insects. Examine the flower carefully. Count the stamens. What colour are they? Distinguish between the sepals and the petals. Carefully open the ovary. Is it possible to count the minute peas? After pollination, this small ovary will expand rapidly to form the familiar pod. Find the remains of the sepals, and perhaps the petals, on a fully formed pod.

Field peas are ready for picking when the pods are sufficiently firm. Large gangs of pickers are required for this operation. A wise farmer will have spread out the drillings in spring to ensure that all the peas are not ready at the same time. At harvest time the farmer will work out how many pickers he is likely to need. An active picker can average 10 bags of green peas each day. A good crop will yield 210 bags per acre. If picking is to be spread over three days, how many pickers are required by the farmer per acre? Why does the farmer spread the period of picking over a number of days? If each bag contains 35 lb. of peas, how would you calculate the number of peas picked by one person in a day? These bags are taken to the marketing centres for sale and distribution. Where is the chief marketing centre in this country for vegetables?

More and more of the field peas grown in this country are now being used for canning and freezing. One of the main reasons for this trend is that the pea is the only vegetable whose cultivation and preservation can be fully mechanized. Peas for canning and freezing are grown under contract with a large company. Under this contract, the company employs a number of trained fieldsmen who work in close co-operation with the farmers. These fieldsmen arrange sowing dates with the grower in order to spread the factory processing over as long a period as possible. They also inspect the growing crop to make sure peas are of good quality. What happens to a crop if the farmer allows it to become too weedy?

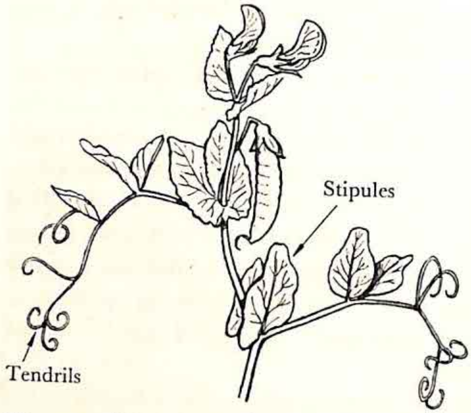


Fig. 43. Upper parts of a pea plant

Collect the labels from various brands of canned peas and cartons of frozen peas. Locate the canning or freezing factory. This will indicate where most of our peas are grown. These factories are generally found in areas where individual farmers may grow several hundred acres of peas each year.

Both the farmer and the fieldsman will decide when a crop is ready for harvesting. The decision is made either by testing the firmness of the pea between finger and thumb, or by using a "maturometer" in the field. The use of this instrument is the scientific method replacing the farmer's "finger and thumb". Once the decision has been made the crop must be harvested with all possible speed. Seeds must be picked and canned in one day, otherwise the characteristic sweetness is lost. Some fieldsmen carry short-wave radio telephones in order to inform the factory immediately a crop can be expected.

The pea plants are cut by a machine which leaves them in long straight rows. What is the name of this machine? A green-crop loader or an elevator will later lift the crop from the ground, and load the peas into lorries or trailers. These loads are either taken to the local factory, or to a large machine on the farm called a "viner". The viner is a very expensive machine to install and is generally used by all the farmers in the area.

If you are able to visit a vining machine, note the loads of peas stacked by the side of the machine. The operators use pitch forks to place the vines on a moving conveyor belt. Peas on this elevator are fed into a large drum. Inside the drum (if it is not working, you can look) the pea plants are tossed about and the pods gently beaten. This removes the shelled peas which are then collected at the side of the viner. The mangled pea plants pass out at the end of the drum. What happens to these? Peas are automatically weighed after leaving the viner. The farmer is paid per cwt. of shelled peas, according to quality.

In this country, 5,000 million cans of food are eaten each year. Many of these are canned peas. A Paris confectioner, Nicolas Appert (1750–1840), is credited with having introduced the first successful method of preserving food in an airtight container. Louis Pasteur, the brilliant French scientist, discovered that bacteria were killed in the heating process. The airtight container prevented any further bacterial decay.

If you visit a canning factory, you will see peas moving along in water which flows through pipes. What advantage has this method of transportation? After grading, the peas are placed in boiling water for blanching. What does this mean? After blanching, peas are weighed into cans on a conveyor belt. What else is placed in the tin? The cans are carried further to a point where they are sealed and cooked in steam under great pressure. All bacteria are now destroyed. Labels are stuck on the tins and they are stacked in cardboard containers ready for dispatch to the shops. They are usually coded to indicate the date of processing.

Peas for freezing receive the same treatment up to the canning stage. A scientist called Clarence Birdseye (1886–1956) was mainly responsible for discovering the methods by which food could be frozen and preserved. Ice was used during the Middle Ages for stacking in large underground chambers where meat, fish and poultry were stored. In a hot summer, however, most of the ice melted and the food decayed. Birdseye spent a holiday with the Eskimos of Labrador. There he noticed how meat, frozen for many months, retained its flavour and tenderness. Birdseye's experiments led to the first commercial products being packed in the United States of America in 1929, and the industry has grown steadily every year since. How many frozen foods are on sale today in our shops?

In a quick-freezing factory, grading is often done by floating peas in brine. Water containing a great deal of salt will cause young peas to float and older

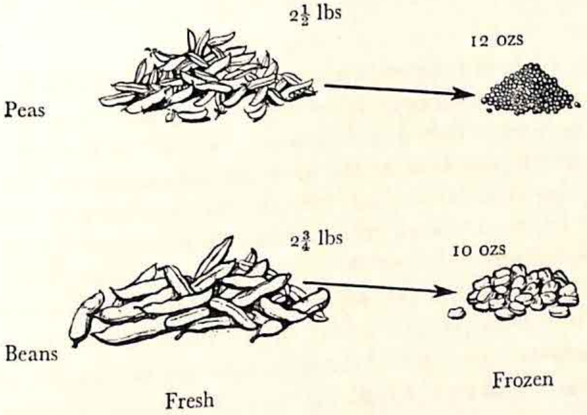


Fig. 44. How much do we waste?

peas to sink. Why is this? Only tender peas are passed along to the freezing department. Here peas are fed into small carton boxes on an endless conveyor belt; they are filled and weighed automatically. The cartons are then laid in single layers on large metal trays to be wheeled away for quick freezing. The freezing may be done by a liquid refrigerant or an air blast. The cartons prevent dehydration whilst in cold storage. What will be the work of this factory for the rest of the year? Shops selling frozen foods are equipped with large refrigerators. The temperature is just low enough to prevent the product from thawing out, and so prevents any bacterial decay.

Finally, peas may be grown for harvesting dry. Peas for this purpose must be planted in areas where reasonably dry weather may be expected in late summer. Which areas are these? The methods of cultivation are similar to those already described. The method of harvesting is different.

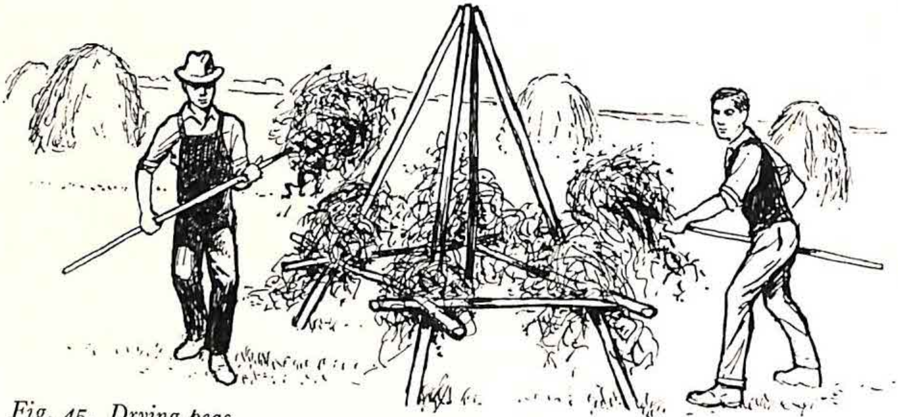


Fig. 45. Drying peas

The crop is ready for harvesting when the pods are full and beginning to change colour. What happens if cutting is delayed? What may cause this delay? An implement called a windrower is used to cut the crop. If you visit a farm in August, look at the way the farmer leaves the cut crop for three or four days on the ground. Why is this? The crop is further dried by being placed on top of three or four poles known as a "tripod". Countries such as Switzerland still use this method for making hay. With peas, approximately 20 tripods per acre will be required. The crop has to be reasonably dry when placed on the sticks. The effectiveness of the drying method depends on the careful building up of the pea haulm on the tripod. Rain cannot enter when the building up is done properly. How is adequate ventilation ensured? Once the peas have settled firmly on the tripod it is difficult to remove them with a pitch fork. Many farmers attach lifter transporters to their tractors so that they can bring the fully loaded tripod to the thresher.

Sometimes peas are taken from the tripods and made into a stack. What is the first task in the making of a stack? Which implement is used to raise the crop up to the stack? Inside the stack, peas will harden and the grain will eventually be removed by threshing. The average yield of dried peas is 20 cwt. per acre. The pea straw is quite useful for feeding to farm animals.

Further Reading

Ministry of Agriculture Publications:

Peas, Bulletin No. 81.

Leaflets: PEA MOTH (334); PEA ROOT EELWORM (462); PEAS FOR DRYING (357); GROWING FIELD PEAS FOR STOCK FEEDING (300).

Chapter 7

Linseed, Hops, Mustard and Sunflower

LINSEED OR FLAX

Flax was certainly one of the first crops to be cultivated and utilized by man. About 5000 B.C. the Egyptians grew flax for the making of linen. Samples of this linen have survived to this day. In Great Britain, flax has been grown and used for over 2,000 years. Very few of our other farm crops have such a long history. In the sixteenth century, an Act of Parliament granted a flax monopoly to Norwich and other towns in the County of Norfolk. Flax growing flourished in East Anglia up to the end of the nineteenth century. Suddenly the popularity of the crop declined—perhaps you can suggest why?

In the 1930's, the late King George V grew a few acres on the Royal Estate at Sandringham in Norfolk. From this 3 cwt. of seed, well over one million acres of flax were to be grown in the Commonwealth for war purposes. In this country also, flax became an important war-time crop. Why does the acreage of flax always increase in times of national emergency?

The other name for flax is linseed. Flax is the name used when the fibre in the stem is converted into linen and these varieties usually have long stems. The plant is called linseed when grown for the production of its seed and there are distinct varieties grown for this purpose. Oil is obtained when the seed is crushed. What is linseed oil used for? Several species of flax (*Linum*) are grown as garden flowers, and they closely resemble the farm species (*Linum usitatissimum*). At the present time very little flax is grown in this country. From which countries do we import our flax and linen supplies? Seed is readily available, however, and the crop will grow well in most garden soils.

On the farm, flax generally follows a cereal crop in the rotation. It is often used as a "nurse crop" for grass seeds. The flax plant (see Fig. 46) has very little foliage to smother seedlings. A fine, firm seedbed is required. Seed is sown at the rate of 80–100 lb. per acre. What type of drill is likely to be used for sowing?

If linseed is grown as a garden crop or in flower borders, note the fine pointed leaves and the delicate shape of the flower. Count the number of sepals and petals. Note how seed capsules are produced at the same time as flower buds. How does this make harvesting difficult on the farm? Pull up a linseed plant and examine the root. You will observe how shallow the root growth is. In which areas of Great Britain will it be difficult to grow linseed because of its rooting system?

Rub out some of the seed from a ripe capsule. Note the shape and colour of the seed. If you crush some, can you find any droplets of oil? The residue after crushing is called linseed cake, and this is a valuable feeding-stuff. Which other seeds are pressed for their oil content, and have husks used for animal feed? Linseed cake contains approximately 30 per cent protein. Which farm animals require a high protein food?

After removing seed, try to break the stem of the plant. Do you find it difficult? In a flax factory, these stems are soaked in water for several days. The process is called "retting". Retting causes the outer stem tissues to decay. The inner tissues or fibres can then be removed by mechanical means. Flax fibres are approximately 2 ft. in length (see Fig. 47). You will note how the walls are thick and strong. Each joint has small "claws" which catch hold of each other when fibres are spun into lengths. This is one of the reasons why flax is the strongest of all commercial bast fibres. Linen made from flax is unrivalled for strength, durability and hard wear. Which articles are made from flax fibres? Which foreign plants producing bast fibres are imported into this country?

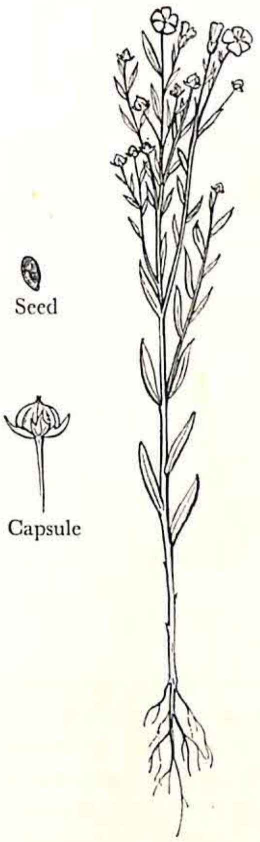


Fig. 46. Linseed plant

Finally, it may be remembered that Jesus was buried in linen made from flax. "This man (Joseph) went unto Pilate and begged the body of Jesus. And he took it down and wrapped it in linen and laid it in a sepulchre."

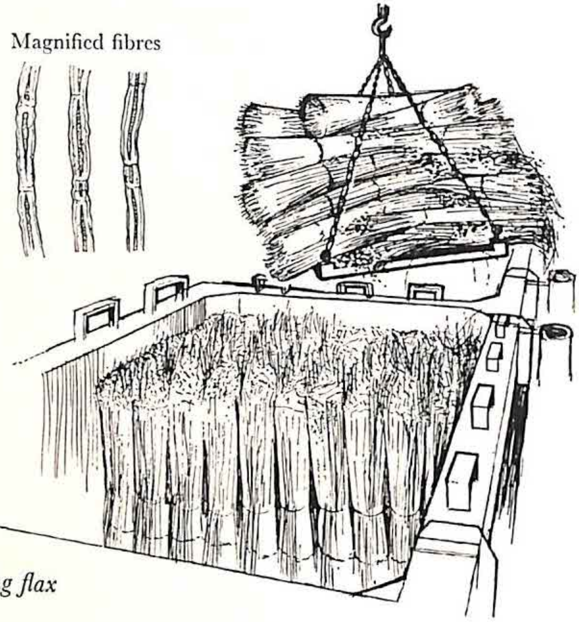


Fig. 47. Retting flax

MUSTARD

Mustard is an important farm crop in this country. The plant belongs to the Cruciferae order, which contains such plants as cabbage, turnip and horse-radish. You will notice how plants belonging to the same botanical family are not similar in all respects. Do you know the names of any weeds belonging to the Cruciferae plant order? There are many varieties of mustard grown in the world. In the Far East, mustard leaves are used in the preparation of salads. In Palestine, mustard grows into a large bush and is a favourite haunt for birds. Can you remember the Bible text beginning "The Kingdom of God is like unto a grain of mustard seed . . ."? The two species of mustard grown on our farms are black or brown mustard (*Brassica nigra*) and white mustard (*Brassica alba*). Both species are used in the manufacture of table mustard. White mustard is often used by the farmer as a "catch-crop".

Mustard seed germinates quickly on moist blotting paper. For this reason, it is often used in experiments to demonstrate the first stages of plant growth. If you germinate mustard seed in this way, examine it after a few days with a hand lens. What is the name given to the first pair of leaves? Note the root hairs extending down most of the primary root. Observe that no root hairs are developed at the tip. When mustard and cress are grown under glass, why is the cress sown four days before the mustard?

When mustard is sown for seed, drilling takes place in March and April. The seed is placed in rows 18 in. apart, at a rate of 5 lb. per acre. Growth is rapid, and this is the reason why mustard may also be used as a farm catch-crop. When are early potatoes taken from the ground? How many more months of summer growth can the farmer expect? Instead of leaving the ground bare, mustard seed is sown at the rate of 20 lb. per acre. What happens to plant food in the soil when the surface is left open for several months? Which other crops are used for catch-cropping? Which farm animals are used to graze these crops? Instead of being eaten off, mustard may be ploughed in to provide "green manuring". In what types of soil will this practice be of greatest benefit? Which crop is likely to follow in the farm rotation?

June is the best month to see a mustard crop in flower. If you are unable to find a field of mustard, you should have no difficulty in finding specimens of charlock weed. The plants belong to the same family and closely resemble each other. You will see that the shape of the lower leaves differs from the leaves above. When the crop is in flower, which insects can you find assisting pollination? How is it possible for the farmer to introduce insects into the crop to help in pollination? After flowering, the seed develops in a long case called a siliqua. A wallflower develops a similar seed-case. How are seeds spread from this case?

After harvesting and threshing, mustard seed is sent to a factory. Here, each bag of seed is sampled and graded on arrival. The first stage in the factory processing is to reduce the moisture content of the seed. How is this likely to be done? The seed is next passed through rollers which reduce grains to a fine powder. Large automatic sifters remove bran from the flour. Which part of the seed is bran? Brown and white flour from the two species of mustard are blended with great care. It has taken many years to perfect the quality of table mustard, and blending is the most important stage in manufacture. When mustard flour is mixed with water, the glucosides are broken down into sugars and oil of mustard. The oil from brown mustard gives the characteristic taste and smell. That from white mustard supplies the subtlety of flavour. Next time you place mustard on a piece of meat, think for a moment how the yellow powder reached your table.

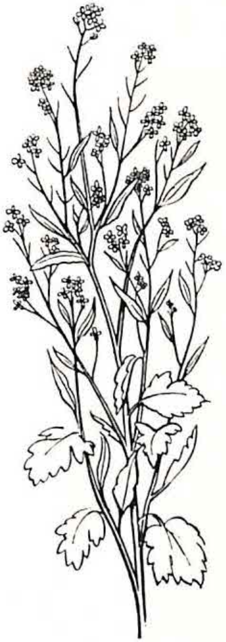


Fig. 48. Mustard plant

HOPS

Hops—unlike some of our farm crops—are indigenous to this country. The crop is thought to have been known to the Romans, but the use of hops was only introduced from Flanders in the middle of the sixteenth century. At this time, the use of hops to flavour beer did not meet with full approval. It was called "a wicked weed that would spoil the taste of the drink and endanger the people." Despite these protests, hops were used in the making of beer, and hop growing was well established in Kent by the end of the seventeenth century. Today, some of our hop supplies still come from Kent. Where else are hops an important crop?

The growing of hops, like that of potatoes and sugar beet, is strictly controlled by a central marketing organization. The function of the Hops Marketing Board is to set a fair price for the crop, and ensure that not too many hops are grown each year. This marketing board supervises the growing of hops in the counties of Kent, Sussex, Herefordshire and Worcestershire. If you do not live in one of these counties, you may have seen the picturesque hop fields and oast houses on the way to your holidays.

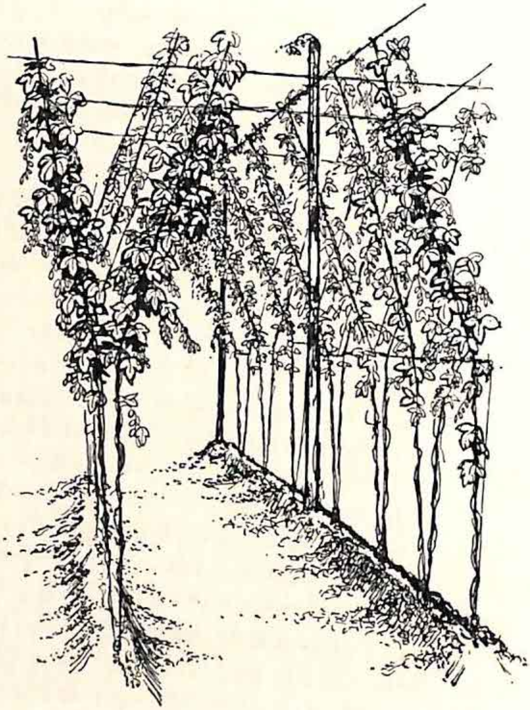
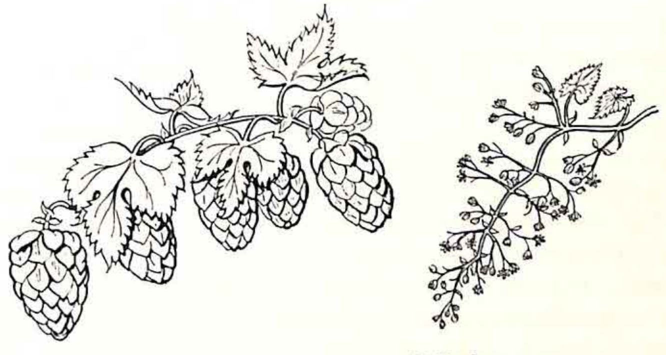


Fig. 49. Hops supported by poles and wires



Female flowers

Male flowers

Fig. 50. Hops

The hop is a perennial climbing plant which dies down to soil level in the autumn. The average life of the hop plant is fifteen years; each year the farmer inspects plants and replaces those which are dead or diseased. The stem of the hop is too weak to stand erect. Plants having weak stems often make their way upwards by attaching themselves to surrounding objects. These are classed as twining or climbing plants. Climbing plants erect themselves by special stem attachments, e.g. tendrils of the pea plant. How many other stem attachments can you name? Hops are twining plants. Which other plants grow by twining their stems round a support? Why do plants need to climb upwards? In your garden, note the direction taken by twining plants. Hops twine clockwise, most plants twine in the opposite direction.

Most of you will have seen pictures of the large poles joined with wire which support the twining hop stems (Fig. 49). In the Spring, hops are trained up strings attached to the top wire. In seven weeks from the beginning of May, the hop plant may attain a height of 15 ft. What is the average daily growth? What will be the probable rates of manure-fertilizer application for plants making such rapid growth? By mid-June, you will be able to see side growths being put out in preparation for the cones or flowers (hops).

The hops that will be picked are formed in late July and early August. They will not be ripe for another month. The male and female flowers grow on different plants, as in the willows. When the "garden" (Kent) or "yard" (Herefordshire) is planted, only female plants are used. Sometimes male plants are grown among the female ones, in order for fertilization to take place. The flower is called a "cone" because of its shape. If you are able to examine the flower, you will notice that it is made up of a series of thin modified leaves called "bracts". Two female flowers are to be found on the upper surface of each bract. The bract is the important part of the plant, as it is covered with glands to keep off insects. These glands provide the characteristic smell of hops, and supply the flavour required in beer-making.

Hop picking begins at the end of August. For many years people from the poorer parts of London spent their holidays in the open air picking hops. The holiday was shared by the whole family living in "hopper huts"—small wooden shacks by the hop fields. Today, machines have largely replaced the hop pickers. Whether picked by hand or machine, hops are taken down from the top wires and placed in "green bags" or "pokes". These bags are taken to the oast houses for drying. Inside the oast house, hops are spread on an open floor covered with a close-mesh net. Air is heated and it rises through the hops and out through the high roof. Which other farm crops are dried by hot air? Which type of coal has to be used in providing heat for drying hops? What is the most modern form of heat for drying? After drying, hops are packed in strong canvas bags and sold to the brewers. You can read how hops are used in brewing in the chapter on barley in *Farm Crops*, Book II.

SUNFLOWERS

Sunflowers have been grown as a farm crop in this country since 1940. You are unlikely to see the crop on a farm scale, but most flower borders contain a

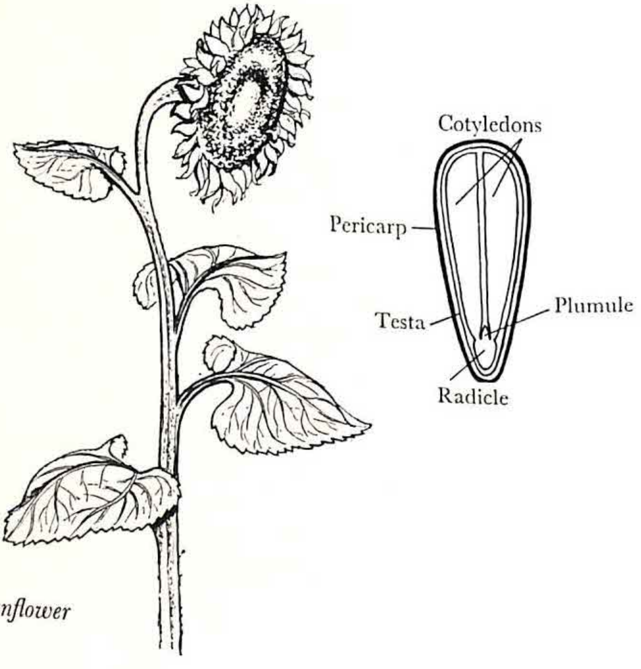


Fig. 51. Sunflower

few specimens. Sunflowers belong to the Compositae order of plants. You will know how most of the Compositae have flowers arranged on a small platform. The dandelion is one example. How many more can you name? What is a frequent method of seed dispersal?

If possible, obtain a sample of sunflower seed (see Fig. 51). Soak for a time in water. The wall of the seed (called the pericarp) can now be removed by a penknife. A thin yellow or brown membrane surrounds the seed, and is called a testa. After removing the testa, examine the embryo plant with a hand lens. You can easily split the part of the seed above the radicle into the two cotyledons. Note the large amount of food they contain. Cut a thin slice from one cotyledon and mount in water under a microscope. If you examine carefully you will be able to make out bright spots of oil. The seed of the sunflower is crushed to remove this edible oil. The outer portions which you have removed (testa and pericarp) are extracted in crushing, and make a useful feeding cake for farm animals. What is the farmer's name for the seed coat? The oil is used in the making of margarine and cooking fat. Which other farm seeds are crushed for their oil content?

On the farm and in the garden, sunflowers will thrive on almost any well-drained soil. Seed is sown at the end of March. After the crop is well up, singling reduces the plant population to ten plants per square yard. You will know from looking at a flower border that sunflowers can attain a height of six feet or more. The plant flowers in August. Eight weeks later the crop is ready for harvesting. On the farm, harvesting is done by a combine harvester. What alterations are made to the harvester to cope with such tall plants? In the garden, sunflower seed may be removed by rubbing the head face downwards on a piece of small-mesh wire. The removal will be made easier if plants are hung upside down in sheds after cutting. If the average farm yield is 15 cwt. to the acre, and the oil content is 35 per cent, how much oil is produced per acre? How do we make use of oils and fats in our diet? At which time of the year are they most necessary?

Further Reading

Ministry of Agriculture Publications:

Hop Growing and Drying, Bulletin No. 164.

Hops Marketing Scheme, 1931, amended 1955.

Leaflets: THE MUSTARD BEETLE (157); VERTICILLIUM WILT OF HOPS (413).

Chapter 8

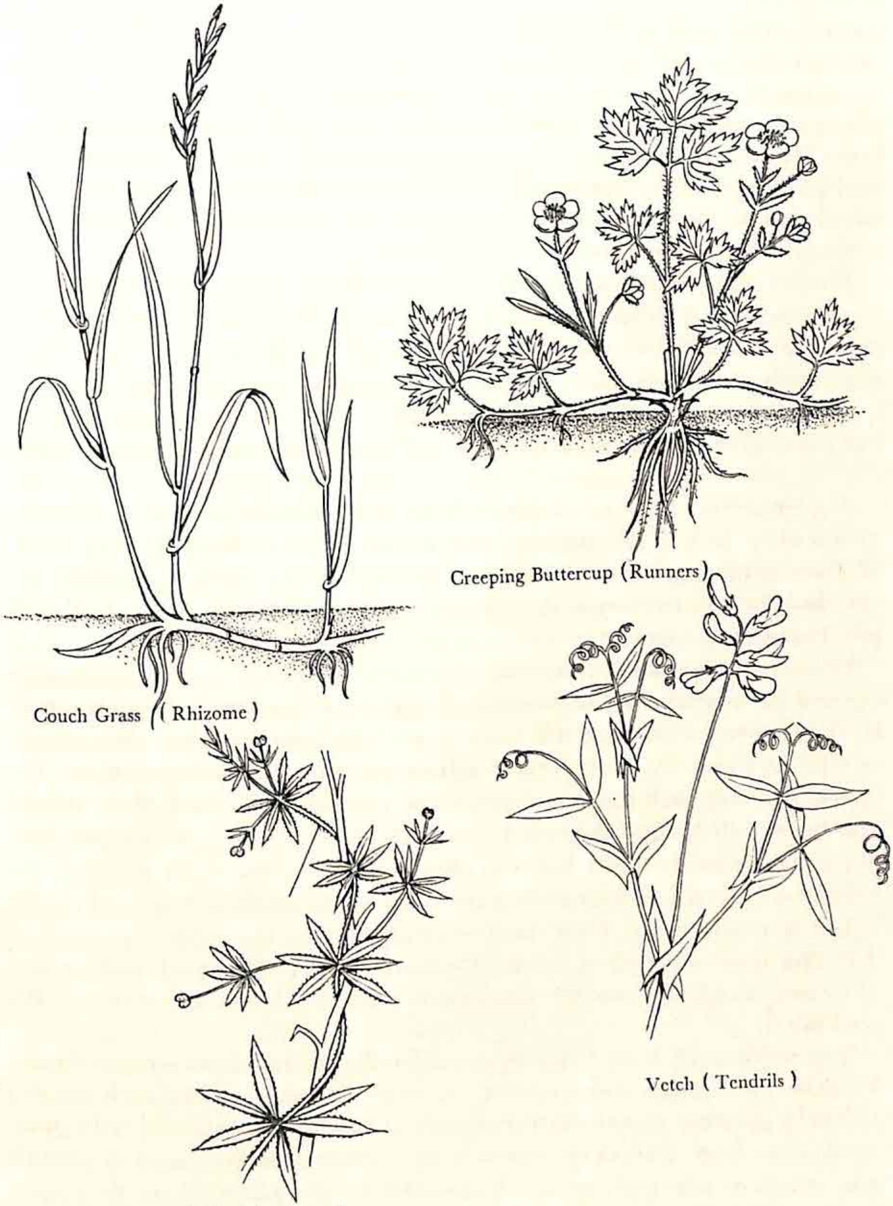
Farm Weeds

Some of our wild plants are able to grow in most unusual places. After the war, bomb sites in the centre of London were soon covered with many different kinds of wild flowers. To "study the flora" of an area is to find out the various species of plants, and how they became established. Although some plants are found growing on roofs and walls, they establish themselves best on open soil. If you remove turf from a patch of ground, note how quickly the area is covered with wild plants. When, in the growing of farm crops, is soil left exposed in this way?

In the hedgerows on your way to school, you will notice several species of wild plant. These have formed a "natural association" with each other, and will appear in the same places year after year. Each plant has its particular habit of growth. Some grow tall, others hardly leave the ground. Some spread along the surface, others below the surface. There is, of course, great competition for food, water and light. Any weak plants have little chance of becoming established. Natural flora occurs on all parts of the earth which have conditions suitable for plant growth, unless man intervenes to modify them.

Note the associations of wild flowers in a hedgerow. Measure a length of the hedgerow, and indicate on a scale drawing where the various plants are to be found. Walk along until you reach a farm gate. The cultivated plants in a field do not grow in a natural association. Farm crops are artificially arranged by the farmer—not by nature. A farm crop is also made up of plants belonging to the same species, each growing in a pre-arranged position. For example, wheat, peas and potatoes. When is it possible to find a farm crop made up of several different species? Any plants which appear in addition to the sown crop are called weeds. You will appreciate that this expression is a very wide one, and it is possible for species of cultivated plants to be called weeds when they appear in the wrong place.

You will already know the way in which farmers are able to arrange where



Couch Grass (Rhizome)

Creeping Buttercup (Runners)

Goosegrass (Climbing stems)

Vetch (Tendrils)

Fig. 52. Some weeds on farms

and when plants are to grow as a farm crop. This was not always possible in the past, when seed was broadcast by hand on to the seedbed. The modern drill not only places seed under ground, but leaves fertilizer available for use immediately after germination. The drill ensures that plants grow in straight rows across the field. How does the spacing differ with cereals and legumes? What happens to open ground, especially during the fast-growing period in Spring? Why does the farmer not sow his wheat much closer to prevent weed establishment? You will know the possible ways of eradicating weeds from crops growing in wide rows.

It is not always possible to grow each farm crop in soil exactly suited to the requirements of the plant. The necessity for a rotation means that some crops are grown in conditions which would normally be unfavourable to them. The man-made plant associations provide a very unequal chance for the crop. The competition, crops versus wild plants (weeds), would be very one-sided without the help of the farmer. How does the farmer come to the aid of his crops?

Any study on farm weeds must begin with a collection of specimens. When on a farm walk, make a note of the crops growing in each field. Without damaging the crop, collect as many different weeds as possible. Do you find the species vary with different crops? Which part of the field will provide most specimens?

When making a weed collection, specimens must be prevented from wilting and losing shape before pressing. A metal box lined with damp rhubarb leaves, or a polythene bag, will keep plants fresh for some hours. Newspaper or blotting paper are the best materials for pressing. Carefully spread out the weeds, opening each leaf and flower. The washed roots of the plant should also be included. Note the various types of roots. When ready for pressing, place the specimens under heavy books for about a week. After pressing, the weeds are best mounted on white paper. A colourless adhesive applied lightly to one side will secure. Press the specimen firmly on the paper and leave to dry. The name of the plant, family, the place where it was found, and method of control should be entered below each specimen. Leave space to add the seed later.

You will quickly learn the names and families of the more common weeds. Whilst collecting specimens, choose one particular weed which you know can be found growing almost anywhere, for example, plantain, shepherd's purse or common dock. Collect specimens from as many different places as possible and compare size and vigour. Relate this to the place where they were growing. Dandelions and plantain may be found growing on a gravel drive, in a lawn, and among farm crops. Note how these weeds are able to withstand the pressure of wheels on a drive, the cutting blades of the lawn mower, and how they avoid being smothered by taller plants. The mode of growth of some species can be adapted to many different environments and conditions.

Some weeds have a further advantage over most farm crops because growth from year to year is not always dependent upon the production of seed. How do bindweed and couch grass spread among farm crops? What is the botanical name for this type of growth? How do briars encroach on a field when the hedge is neglected? What happens to the root of the common dock when a cultivator cuts it in half? You will note that many of our weeds are perennials. Thanks to their habit of growth weeds can be far more persistent than farm crops.

Although weeds often show remarkable adaptation to their place of growth, it is possible to use them as an indicator of soil conditions. If possible, visit a field which you know to be sour and badly drained. The sides of a stream may give you the same conditions. Collect specimens of the wild plants growing there. Lady's-smock, meadow-sweet and knotgrass are always reliable indicators of a badly drained field. A limestone soil will also have weed indicators. The most reliable are burnet, scabious and wild thyme. Which weeds indicate peaty soils? Whenever you see ox-eye daisy and ragwort, you may be sure the soil is poor. Farmers know these signs only too well, and they often assess the skill of their neighbours by the weeds growing on the other side of the hedge. Good soils may also be indicated by certain weeds. There is the story of the blind farmer who wanted to buy a field belonging to his neighbour. As he was being taken through the gate, he asked to be led to the

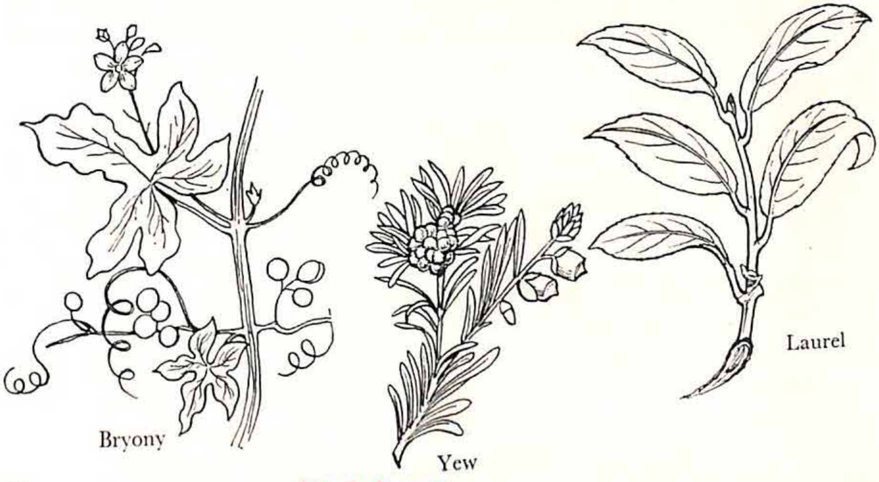


Fig. 53. Poisonous plants of the hedgerows

nearest patch of thistles. Feeling with his stick, he noted the height of the thistles to be between 3 and 4 feet. He promptly bought the field.

There are several ways in which weeds can reduce the income of a farmer and cause him much inconvenience. The most obvious is in the reduction of yield he may expect from his crops. If you sow a row of seed in the garden and forget to do any weeding, you know how quickly the row disappears among a mass of weeds. Examine such a row and suggest four reasons for the effective control of weeds. On the farm, deep underground weed roots also block drainage tiles. What happens to the soil?

You will already know that yew and laurel are poisonous when fed to animals. Collect a few laurel leaves. Chop them up finely and place in an airtight jar containing a few insects. What happens? There are a number of weeds which can poison farm animals. Be careful never to feed ragwort, nightshades or bryony to your rabbit. Other weeds can cause taints in milk. Try to collect some of the strongly scented ramsons and wild onions. If you chop up an onion and leave to soak for a while in a cup of milk, you will realize why a dairy farmer cannot sell tainted milk.

It is not always realized that many weeds cause harm to farm crops by being a host to pests. You will know from your weed collection that weeds belong to families or orders like any other plants. Shepherd's purse and charlock, for example, are as worthless members of the Cruciferae as turnips and kale are useful. If a pest or disease is able to attack one member of the plant family, other members of the family may act as an alternative host. You will realize the importance of this if you examine your weed collection, and note how many weeds belong to families containing farm crops. Examine dandelions, docks and thistles for mangold fly (already described in mangold

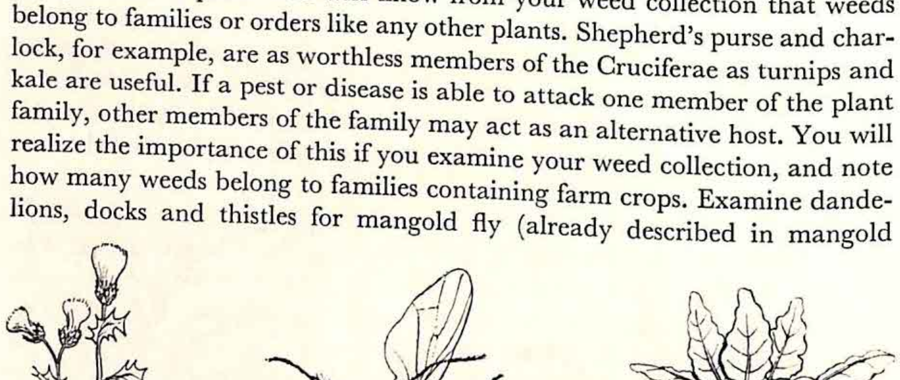


Fig. 54. Weeds as alternative hosts to farm pests

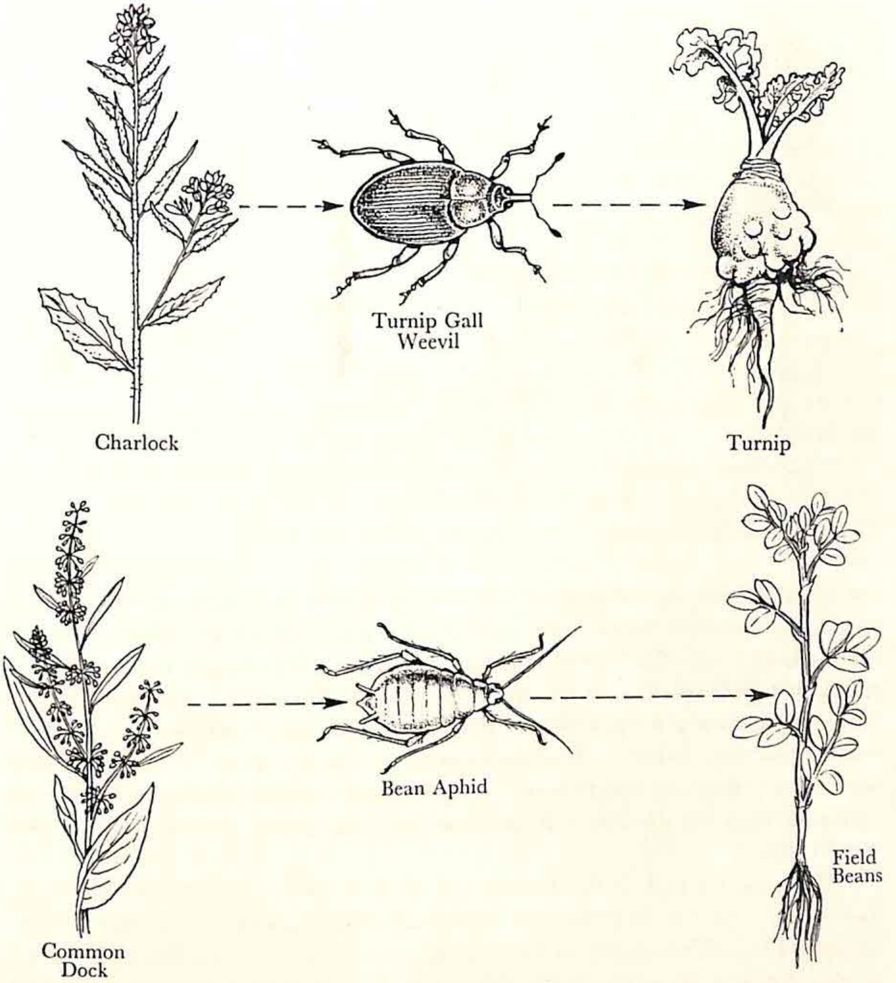


Fig. 54 (continued). Weeds as alternative hosts to farm pests

chapter). Check the leaves of shepherd's purse for rust, and charlock roots for finger-and-toe. How can some pests and diseases pass the winter when their normal host has been removed? How do these weeds reduce the effectiveness of a farm rotation? You will notice that not all alternative hosts are in the same families.

You can take weed seed-counts at almost any time in the summer and autumn months. It is best to select a number of weeds for this purpose, while the plants are in flower. This will ensure that none of the seed is lost before

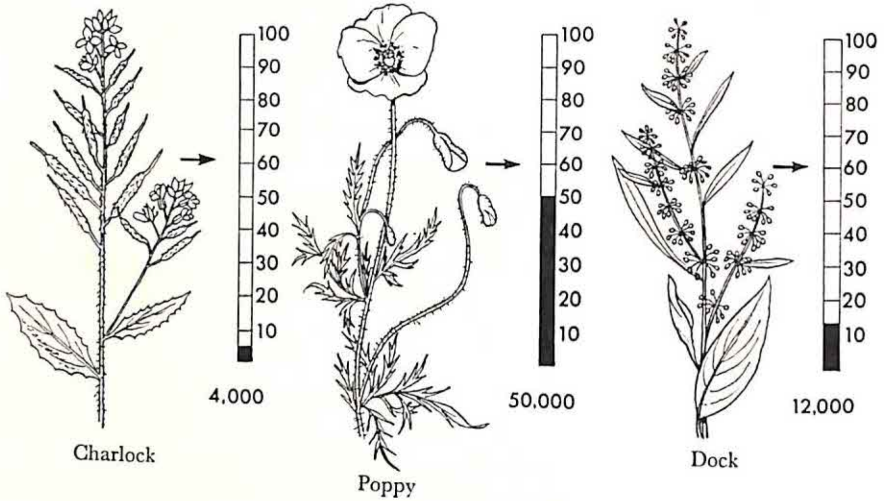


Fig. 55. Seed counts of some farm weeds

the count begins. If the seed is contained in a case or fruit, find the correct botanical name for this container. Look for examples of a follicle, legume, silicule and a capsule. Which of these four occur with poppy and shepherd's purse? If possible, collect a few ripe poppy heads. Carefully open the capsule. You will require a lot of patience if you are to count all the seeds (approximately 50,000). When it will obviously take far too long to count all the seeds in a container, the procedure should be as follows. Count all the seed you can pick up between finger and thumb. From this, calculate the remainder.

Find a field which is badly infested with weeds and take a weed count inside 40 or 50 sq. yds. Note how many different species of weed are contained within this area. If an acre contains 4,840 sq. yds. estimate the weed population per acre. You may have taken seed counts for some of these weeds; estimate how many weed seeds are likely to be distributed in a single year. Which class of plants produces the greatest number of seeds? During the summer months, collect as many different weed seeds as possible, and note how they are arranged on the plant. The seeds are best stored in small glass specimen tubes. The name of the seed should be printed on a label and attached to the container. With a hand lens, you will soon be able to recognize the shapes and sizes of the more common seeds. Carefully remove seed of species you have collected and pressed. Place them on a piece of sticky transparent tape. This tape will keep the seed in place and may be mounted beside the pressed weed. The method of dispersal should also be written down.

More of your weed-seed collection may be used in germination tests. These tests cannot be used to find accurately the percentage of "live" seed. This is because weed seed may take months or even years to germinate. Charlock seed has been known to germinate after forty years. You can find out a few of these germination periods by keeping seed on damp blotting paper. Take a few soil samples from different fields and note the seeds which germinate inside the laboratory. What problems does seed dormancy cause the farmer? Note the appearance of young weed seedlings, so that you can recognize them again.

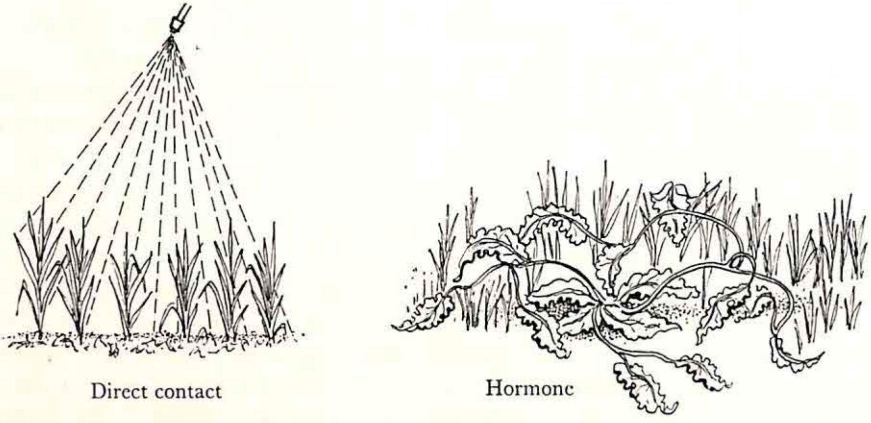
By now, you will realize the great number of weed seeds to be found in almost any soil. The farmer's task is to use every possible method to prevent the further build-up of seed in his fields. This is only possible if a study is made of dispersal methods on the farm. In the past, many weeds appeared among farm crops because seed merchants did not properly clean grain used for sowing. Today, the Seeds Acts make it illegal to sell impure seed. If you are able to obtain a sample of uncleaned grain you will realize why legal regulations are necessary. Seed-cleaning machines remove many of the impurities. A second way in which weeds are spread is in unheated farmyard manure. The heat inside a well-built manure heap will kill seeds. Manure which is applied direct to the land may contain a large number of seeds. The mud attached to the wheels of a tractor or the farmer's boots may also contain weed seeds.

A farmer can take all the preventive measures but still have a weed-infested crop; there is little he can do if his neighbour is a bad farmer and allows clouds of thistle seed to be blown over the hedge. Actually, we all help to carry seed around. Carefully brush the dust, etc., from your trouser turn-ups into a pot of sterilized soil. Do any seeds germinate?

However efficient a farmer may be, there will always be weeds to control. In order to maintain an artificial plant association, a farmer must take both direct and indirect action. How, for example, will a good rotation help? Why is good drainage necessary? What part will lime play in the battle against weeds? Which farm crops smother weeds? Which are "cleaning crops", and how do they reduce weed numbers? What is meant by stubble cleaning? Why does a farmer "fallow" land?

In the past, direct action was taken by gangs of men either hoeing or digging out weeds in the standing crop. Why has the sprayer replaced this method? Today the farmer possesses an armoury of more than 140 killing chemicals. Some destroy pests, others destroy weeds. Unfortunately, the natural allies of the farmer are sometimes killed at the same time. This also happens when road-sides are sprayed by local councils. It is better to have a few weeds than to destroy many useful or beautiful wild plants.

Weed killing chemicals on the farm can be divided into: (*a*) the non-selective; (*b*) the selective. An example of a non-selective killer is sodium chlorate. Where will it be possible to use this chemical? What care has to be taken in handling and application? The selective weed killers are effective either by direct contact with the plant leaves, or by a hormone effect. Which farm crops have leaves sufficiently narrow to allow the passing of a spray on to the weeds below? Hormone weed killers are more effective and safe. When applied to weeds, distorted growth will result and the plant will die. You will know how hormones regulate growth both in animals and plants. How is it possible to use a hormone as an aid to plant growth? Most hormone killers have very long names, and are better known by their initials. Do you know what M.C.P.A., D.N.O.C., and 2.4.D stand for? Spraying is done by machine (described in detail in Book 13) or by aeroplane. Why is it always important to observe wind speed and direction?


Direct contact

Hormone

Fig. 56. Two methods of weed control by spraying

After all that has been written on the harmful effects of weeds, it is worth noting some of their values. Weeds have provided parents for many of our garden vegetables and flowers. In the past, many strange and potent medicines were made from weeds. Some of them are still used today. Foxglove (*Digitalis*), for instance, is used in the making of a drug (digitalin) required in the treatment of some forms of heart disease. Deadly nightshade and poppy are also sought after by the drug industry. As weeds were the "Mother of

Medicine", many of the common names we use today relate to their medicinal use in the past. Self-heal was at one time highly regarded as a medicine for inward and outward wounds. So too was yarrow (*Achillea millefolium*), meaning a thousand leaves. The leaves acted in the same way as cotton wool on a wound. The blood is spread out to the air—coagulation takes place—and the bleeding ceases. Achilles used the leaves of this plant on the wounds of his soldiers. Country people still use yarrow to stop nose-bleed; it is often known as bloodwort.

Weeds are also given credit for assisting in the prevention of soil erosion, and adding humus to the soil. Many wild animals rely on weeds for their food; perhaps you feed your rabbits on selected weeds. In grassland, some weeds are richer in minerals than the normal grasses and are sought out by grazing animals.

In natural flora, there is room for all species. Only man's interference in nature has led us to approve of one plant and disapprove of another. We are always learning how interference in the delicate balance of nature can bring disastrous results. This is due to unscrupulous exploiting of land in extreme cases or to the limitations of man's knowledge at the time. Crops must be grown for the survival of the world, and increased populations necessitate higher crop yields. Man must profit from lessons of the past and try to anticipate the full consequences of new developments before accepting them.

Further Reading

Farm Weeds by J. DEARDEN. Y.F.C. PUBLICATION (EVANS BROS.).

Ministry of Agriculture Publications:

Identification of Seedlings of Common Weeds, Bulletin No. 179.

Leaflets: BINDWEEDS (450); CONTROL OF BRACKEN (190); CONTROL OF RUSHES (433); COUCH AND TWITCH (89); DOCKS AND SORRELS (46); KNOTGRASS AND ALLIED WEEDS (432); RAGWORT (280); THISTLES AND THEIR CONTROL (51); WILD OATS (452); WILD ONIONS (313).

Glossary of Flowering Plants

Flowering plants which reproduce themselves by seeds may be divided into two main groups:

(*a*) *The GYMNOSPERMS.* This group contains many of our familiar trees and shrubs. The most important are the conifers, or cone bearing trees. Our woods and shrubberies contain well-known examples such as the Pines, Firs, Larches, Yews, Spruces, Cypresses and the Junipers. All these plants have ovules fertilized by pollen grains falling on to them.

(*b*) *The ANGIOSPERMS.* These have the ovules contained in an ovary, and are only fertilized when the pollen tubes grow from the stigma. The Angiosperms contain the great majority of our flowering plants. These are divided into two main classes:

MONOCOTYLEDONS	DICOTYLEDONS
Developing one cotyledon leaf	Developing two cotyledon leaves
Adventitious root system	Develops a primary root system
Stem has no central pith and scattered vascular bundles	Stem has central pith and circular vascular bundles around stem
Leaf veins run parallel	Leaves net-veined

DICOTYLEDONS

Order RANUNCULACEAE. Buttercup, Wood Anemone, Celandine, Marsh Marigold, Larkspur, Paeony, Clematis.

Order CRUCIFERAE. Cabbage, Brussels Sprouts, Cauliflower, Broccoli, Turnips and Swedes, Kale, Kohl-Rabi, Mustard, Radish, Wallflower, Charlock, Shepherd's Purse, Nasturtium.

Order LEGUMINOSAE. Peas and Beans, Clovers and Vetches, Lupin, Sainfoin, Laburnum, Gorse.

Order ROSACEAE. Pear and Apple, Hawthorn, Roses, Blackberry, Bramble, Strawberry.

Order UMBELLIFERAE. Hedge Parsley, Hogweed, Hemlock, Parsley, Carrot.

Order LABIATEAE. Sage, Mint and Thyme, Ground Ivy, Self-Heal, Hemp and Dead Nettle, Lavender.

Order COMPOSITAE. Sunflower, Dandelion, Thistle, Burdock, Chicory, Knapweed, Yarrow, Stinking Mayweed, Groundsel, Daisy.

Order SOLANACEAE. Potato, Tomato, Deadly Nightshade, the Tobacco Plant, Petunia, American Thorn Apple.

Order POLYGONACEAE. Docks and Sorrel, Knotgrass, Rhubarb, Buckwheat.

Order CHENOPODIACEAE. Sugar Beet, Wild or Sea Beet, Swedes and Mangolds.

MONOCOTYLEDONS

Order GRAMINACEAE. Wheat, Oats, Barley, Rye, Maize, Rice, Millet, Reeds, Marram Grass. The cultivated and wild species of grass.

(There are, of course, many other plant families. You will be able to find a complete classification in any comprehensive botany textbook.)

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